PRESSURE REGULATED VOLUME CONTROL VERSUS BIPHASIC POSITIVE AIRWAY PRESSURE IN MECHANICALLY VENTILATED PATIENTS WITH ACUTE LUNG INJURY

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Abstract
Acute lung injury (ALI) and acute respiratory distress syndrome (ARDS) are characterized by inflammatory response to a local (pulmonary) or remote (systemic) insult resulting in injury to alveolar epithelial and endothelial barriers of the lung, leading to hypoxemia and respiratory failure. Objective: This study aimed to determine the difference between PRVC and BIPAP modes in mechanically ventilated patients with an acute lung injury. Methods: This study was carried out on 74 consecutive adult patients, who were admitted to the units of Critical Care Medicine department in Alexandria Main University Hospital and diagnosed as acute lung injury. The studied patients were serially randomized into two groups using the closed envelop method, Group I: Including (37) patients in whom the BiPAP mode of mechanical ventilation was applied and Group II: Including (37) patients in whom the PRVC mode of mechanical ventilation was applied. The following parameters were measured in the patients of both groups: Hemodynamics, Lung mechanics on mechanical ventilation, days of ICU stay, days of mechanical ventilation, Patient ventilator dyssynchrony and mortality and Incidence of VAP. Results: There was no statistically significant difference between the two groups as regards heart rate and mean arterial blood pressure. There was statistically significant decrease in the mean and peak airway pressure in the PRVC group compared to BIPAP group in the first 3 days. There was no statistically significant difference between the two groups as regards calculated lung parameters. There was statistically significant increase in hypoxic index (PaO2/FiO2) in the first three days in the PRVC group compared to BIPAP group without significant difference in PaO2, PaCO2 , There was no statistically significant difference between the two groups as regards Patient ventilator dyssynchrony and mortality & ventilator associated pneumonia. Also there was no statistically significant difference between the two groups as regards ICU & ventilator days. Conclusions: PRVC ventilation is beneficial mode of ventilation that decrease both peak and mean air way pressure and can improve oxygenation in patients with acute lung injury in comparison with BIPAP ventilation.

Introduction
In 1994, the first American European Consensus Conference (AECC) published these consensus-derived definitions of ALI and ARDS: acute onset, bilateral pulmonary infiltrates on chest radiograph consistent with pulmonary edema, poor systemic oxygenation, and the absence of evidence of left atrial hypertension. The ratio of arterial oxygen tension (PaO2) to the fraction of inspired oxygen (FiO2), PaO2/FiO2 was chosen to reflect the degree of hypoxemia even when measured at different FiO2. The syndrome is called ALI when this ratio is ≤300 and ARDS when ≤ 200. The AECC coined the term acute lung injury in order to identify patients who are early in the course of their ARDS and those who may have a form of acute hypoxemic respiratory failure (AHRF) that is milder than ARDS. The Berlin Definition of ARDS (published in 2012) has replaced the American-European Consensus Conference’s definition of ARDS (published in 1994). However, it should be recognized that most evidence is based upon prior definitions.

Mechanical ventilation is the cornerstone of management of ARDS. The best ventilator strategy to treat and manage ARDS is a debatable subject. BIPAP is a pressure-controlled ventilation, during which unrestricted spontaneous breathing is possible in each phase of the respiratory cycle. It delivers a preset inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP). BIPAP can be described as a Continuous Positive Airway Pressure system with a time-cycled change of the applied CPAP level. The circuit switches between a high and a low airway pressure level in an adjustable time sequence. At both pressure levels, the patient can breathe spontaneously in a CPAP system. In recent years, dual-control modes has been introduced in an attempt to combine the attributes of volume ventilation with the attributes of pressure ventilation, to avoid both the high peak airway pressures of volume ventilation and also the varying tidal volume that may occur with pressure ventilation. Pressure-regulated volume control (PRVC) mode is a kind of dual-control ventilation that uses tidal volume as a feedback control for continuously adjusting the pressure limit. Pressure-regulated volume control (PRVC) is a new mode of ventilation that combines the advantages of the decelerating inspiratory flow pattern of a pressure-control mode with the ease of use of a volume-control (VC) mode. This mode, by the name of PRVC, is only available on the Maquet Servo-i ® and Servo 300 ®, but is characteristic of all ventilators with dual modes, such as: Volume Control Plus (VC +, Puritan Bennett ®), adaptive pressure ventilation (Hamilton Galileo), AutoFlow (Drager ®).
Aim of the work

The aim of this work was to determine the difference between PRVC and BIPAP modes in mechanically ventilated patients with an acute lung injury.

Patients and Methods

This study was carried out according to sample size calculation (NCSS 2004 and PASS 2000 Program) on 74 adult critically ill patients with acute lung injury who were admitted to the units of the critical care medicine department of the Alexandria Main University Hospital.

Inclusion criteria:

Adult patients of both sex above 18 years old with acute lung injury indicated for mechanical ventilation according to AECC criteria.

Exclusion criteria:

Pregnant females.

Patients with an expected ventilator therapy of less than 5 days.

Patients with intracranial pathology.

All patients included in the study were subjected on admission to the followings:

Approval of the medical ethics committee of Alexandria faculty of Medicine.

Informed consent was taken from the patient or the first degree relatives of the patient.

Complete history taking.

Complete physical examination.

Complete chest examination and a chest x-ray were done.

Routine laboratory investigations including: CBC, Na, K, random blood sugar, PT, PTT, INR, BUN and creatinine were done for correction of any changes in their values.

Arterial blood gases were withdrawn for all patients on admission and every 12 hours and taking the mean daily for five days.

Etiology of acute lung injury was recorded.

Patient management: During the ICU stay all patients were managed according to the National Institutes of Health ARDS Network low-VT protocol.

All patients were sedated using midazolam infusion. (Usual dosage range for continuous infusion: 0.04-0.2 mg/kg/hour).

The studied patients (74) patients were serially randomized into two groups using the closed envelop method:

Group I: Including (37) patients in whom the BiPAP mode of mechanical ventilation was applied.

Group II: Including (37) patients in whom the PRVC mode of mechanical ventilation was applied.

The period of the study was 5 days starting from beginning of mechanical ventilation.

Measurements and timing:

Hemodynamics including:

Heart rate and mean arterial blood pressure were monitored daily all over the patient stay in ICU.

Monitored lung parameters including:

Respiratory rate (breath/min).

Tidal volume (ml).

Peak airway pressure (cm H2O).

Mean airway pressure (cm H2O).

All of the above parameters were monitored once daily all over five days on mechanical ventilation.

Calculated lung parameters: All patients were applied to the AC volume mode once daily for 10 minutes during this time the following parameters were calculated:

Static compliance (mL/cm H2O).

Inspiratory resistance (cm H2O/(L/sec)).

Rapid shallow breathing index (breaths/min/L).

Auto PEEP (cmH2O).

Work of breathing (joules/L).

Sedation score using Ramsay scale.

Arterial blood gases were obtained daily and recorded:

● \( P_{aO_2} \) (mmhg).

● \( P_{aCO_2} /FiO_2 \).

● \( SpO_2 \) (%).

● \( P_{aCO_2} \) (mmhg)

Patient ventilator dysynchrony were monitored and recorded daily including:

Flow dysynchrony.

Cycling dysynchrony.

Triggering dysynchrony.

Mortality on day 7 to day 28 were recorded.

Days of ICU stay.

Incidence of early& late onset VAP.

The number of days on the ventilator.

Statistical analysis

All data were prospectively collected, coded and tabulated then subjected to statistical analysis using SPSS for windows version 15.0 software package. Numerical variable were presented as mean and standard deviation (SD) while categorical variable were presented as number of cases and percent. Between groups comparison of numerical variable was performed with unpaired student-T test while those of categorical variable were performed by Fisher Exact test or Chi-Square test as appropriate. For all tests p value of less than 0.05 is considered statistically different.
Results

There was no significant difference between the two groups as regards the demographic data, heart rate and mean arterial blood pressure, respiratory rate and tidal volume as shown in table (1,2).

Table (1) : Comparison between the studied groups according to demographic data.

<table>
<thead>
<tr>
<th></th>
<th>BIPAP group (n=37)</th>
<th>PRVC group (n=37)</th>
<th>Test of sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>24</td>
<td>64.9</td>
<td>20</td>
</tr>
<tr>
<td>Female</td>
<td>13</td>
<td>35.1</td>
<td>17</td>
</tr>
<tr>
<td>Age (year)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD.</td>
<td>53.84 ± 14.36</td>
<td>52.11 ± 12.54</td>
<td></td>
</tr>
</tbody>
</table>

p: p value for comparing between the two studied group, t: Student t-test, χ²: Chi square test

Table (2) : Comparison between the studied groups according to hemodynamics, respiratory rate and tidal volume.

<table>
<thead>
<tr>
<th></th>
<th>PRVC</th>
<th>BiPAP</th>
<th>Test of sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR</td>
<td>96.68 ± 11.26</td>
<td>99.84 ± 11.40</td>
<td>t p=0.234</td>
</tr>
<tr>
<td>MABP</td>
<td>85.05 ± 10.75</td>
<td>83.27 ± 8.66</td>
<td></td>
</tr>
<tr>
<td>RR</td>
<td>25.32 ± 3.84</td>
<td>29.76 ± 4.46</td>
<td></td>
</tr>
<tr>
<td>VT</td>
<td>451.49 ± 21.69</td>
<td>445.68 ± 24.67</td>
<td></td>
</tr>
</tbody>
</table>

p: p value for Student t-test for comparing between the two studied group*: Statistically significant at p ≤ 0.05

There was statistically significant decrease (P=0.001) in the mean peak airway pressure in the PRVC group compared to BIPAP group in the first 3 days of the study as shown in table (3).

Table (3): Comparison between the studied groups according to peak and mean airway pressure (cmH₂O).

<table>
<thead>
<tr>
<th></th>
<th>PRVC</th>
<th>BiPAP</th>
<th>Test of sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAP</td>
<td>34.89 ± 4.43</td>
<td>31.08 ± 4.57</td>
<td>t p=0.001</td>
</tr>
<tr>
<td>MAP</td>
<td>16.91 ± 2.59</td>
<td>14.76 ± 2.08</td>
<td></td>
</tr>
</tbody>
</table>

p: p value for Student t-test for comparing between the two studied group*: Statistically significant at p ≤ 0.05
The study showed that there was no significant difference between the two groups as regards sedation score and Patient ventilator dyssynchrony using Ramsay Scale, midazolam infusion rate and Patient ventilator dyssynchrony as shown in table (6).

Table (5): Comparison between the studied groups according to Arterial blood gases.

<table>
<thead>
<tr>
<th></th>
<th>PRVC</th>
<th>BiPAP</th>
<th>Day one</th>
<th>Day two</th>
<th>Day three</th>
<th>Day four</th>
<th>Day five</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PaO₂</td>
<td>96.51 ± 24.12</td>
<td>101.76 ± 28.08</td>
<td>98.22 ± 18.04</td>
<td>102.70 ± 20.60</td>
<td>103.12 ± 20.28</td>
<td>105.07 ± 21.07</td>
<td>107.16 ± 22.03</td>
</tr>
<tr>
<td>P</td>
<td>0.392</td>
<td></td>
<td>0.322</td>
<td>0.557</td>
<td>0.442</td>
<td>0.378</td>
<td></td>
</tr>
<tr>
<td>P₂O₂/FIÖ₂</td>
<td>217.04 ± 27.44</td>
<td>230.81 ± 31.52</td>
<td>230.17 ± 32.74</td>
<td>247.57 ± 40.94</td>
<td>240.36 ± 38.83</td>
<td>253.07 ± 34.97</td>
<td>262.60 ± 35.43</td>
</tr>
<tr>
<td>P</td>
<td>0.049</td>
<td></td>
<td>0.047</td>
<td>0.047</td>
<td>0.460</td>
<td>0.635</td>
<td></td>
</tr>
<tr>
<td>SPO₂</td>
<td>96.78 ± 2.82</td>
<td>96.84 ± 2.71</td>
<td>97.16 ± 3.66</td>
<td>97.54 ± 2.19</td>
<td>98.05 ± 1.43</td>
<td>98.27 ± 1.70</td>
<td>98.36 ± 0.91</td>
</tr>
<tr>
<td>P</td>
<td>0.774</td>
<td></td>
<td>0.768</td>
<td>0.980</td>
<td>0.753</td>
<td>0.576</td>
<td></td>
</tr>
<tr>
<td>PCO₂</td>
<td>46.03 ± 3.84</td>
<td>45.86 ± 2.26</td>
<td>43.08 ± 3.31</td>
<td>44.38 ± 3.22</td>
<td>41.11 ± 2.05</td>
<td>40.33 ± 2.14</td>
<td>40.04 ± 1.78</td>
</tr>
<tr>
<td>P</td>
<td>0.864</td>
<td></td>
<td>0.092</td>
<td>0.871</td>
<td>0.819</td>
<td>0.717</td>
<td></td>
</tr>
</tbody>
</table>

p: p value for Student t-test for comparing between the two studied group  *: Statistically significant at p ≤ 0.05

Table (6): Comparison between the studied groups according to Midazolam infusion rate, Sedation score and Patient ventilator dyssynchrony

<table>
<thead>
<tr>
<th></th>
<th>PRVC</th>
<th>BiPAP</th>
<th>Day one</th>
<th>Day two</th>
<th>Day three</th>
<th>Day four</th>
<th>Day five</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid. infusion rate</td>
<td>0.12 ± 0.05</td>
<td>0.11 ± 0.04</td>
<td>0.12 ± 0.06</td>
<td>0.12 ± 0.04</td>
<td>0.10 ± 0.06</td>
<td>0.09 ± 0.06</td>
<td>0.07 ± 0.05</td>
</tr>
<tr>
<td>P</td>
<td>0.745</td>
<td></td>
<td>0.714</td>
<td>0.321</td>
<td>0.988</td>
<td>0.711</td>
<td></td>
</tr>
<tr>
<td>Sedation Score</td>
<td>3.92 ± 1.06</td>
<td>3.86 ± 0.42</td>
<td>3.95 ± 1.15</td>
<td>3.54 ± 0.69</td>
<td>3.81 ± 1.17</td>
<td>3.62 ± 1.24</td>
<td>3.0 ± 1.21</td>
</tr>
<tr>
<td>P</td>
<td>0.984</td>
<td></td>
<td>0.448</td>
<td>0.674</td>
<td>0.304</td>
<td>0.615</td>
<td></td>
</tr>
<tr>
<td>Flow dys. (%)</td>
<td>18.9</td>
<td>13.5</td>
<td>8.1</td>
<td>5.4</td>
<td>3.3</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.528</td>
<td></td>
<td>1.000</td>
<td>0.612</td>
<td>1.000</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Cycling dys. (%)</td>
<td>24.3</td>
<td>16.2</td>
<td>5.4</td>
<td>5.4</td>
<td>6.7</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.386</td>
<td></td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Triggering dys. (%)</td>
<td>24.3</td>
<td>21.6</td>
<td>13.5</td>
<td>13.3</td>
<td>12.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
There was no significant difference between the two groups as regards mortality & ventilator associated pneumonia and ICU & ventilator days as shown in table (7).

Table (7) : Comparison between the studied groups according to Mortality, VAP, ICU and Ventilator days.

<table>
<thead>
<tr>
<th></th>
<th>BIPAP group</th>
<th>PRVC group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality (%)</td>
<td>5.4</td>
<td>2.7</td>
</tr>
<tr>
<td>VAP (%)</td>
<td>13.5</td>
<td>10.8</td>
</tr>
<tr>
<td>ICU days ( Mean ± SD.)</td>
<td>7.38 ± 0.98</td>
<td>7.03 ± 0.83</td>
</tr>
<tr>
<td>Ventilator days (Mean ± SD)</td>
<td>5.68 ± 0.88</td>
<td>5.49 ± 0.61</td>
</tr>
</tbody>
</table>

Discussion

In our study, as regards demographic data there was no statistically significant difference between the two studied groups as regards age and sex. Similarly in the study of Samantaray et al (12) which was conducted among 36 post-cardiac surgical patients admitted to Intensive Care Unit with diagnosis of acute lung injury found that there was no statistically significant difference between the two studied groups as regards age and sex.

In the current work, as regards the etiology of acute lung injury in group I; pneumonia and lung contusion was the major cause of acute lung injury (21.6%) followed by sever sepsis (18.9%) while in group II; pneumonia was the major cause of acute lung injury (29.7%) followed by sever sepsis (21.6%) and lung contusion (16.2%). This could be explained by the high incidence of pneumonia which considered the most common predisposing condition for acute lung injury (13).

Heart rate and Mean arterial blood pressure were recorded as simple parameters that could reflect the hemodynamic state of the patient. In the current study, there was no statistically significant difference between the two groups all over the five days of the study as regards heart rate and mean arterial blood pressure.

In agreement with our study is the study of Alvarez et al (14) which was conducted among ten patients with acute respiratory failure to analyze the effect of a pressure-regulated volume-controlled ventilation mode in comparison with pressure-controlled ventilation (PCV) on lung mechanics and gas exchange found that there was no statistically significant difference between the two groups as regards heart rate and mean arterial blood pressure. Similarly AbouShehata et al (15) found that there was no statistically significant difference between the two groups as regards heart rate and mean arterial blood pressure.

In the present work, as regards the mean values of respiratory rate and tidal volume; there was no statistically significant difference between the two groups. In agreement with our study is the study of Alvarez et al (14) and Richard et al (16) who found that there was no statistically significant difference between PRVC group compared to the PCV group as regards respiratory rate and tidal volume. PRVC has the theoretical advantage over PCV of ensuring a fixed V̇E but it remains to be established whether these differences are sufficient to be of therapeutic interest. (14)

Peak airway pressure or peak inspiratory pressure (PIP) is the maximum pressure generated during inspiration. PIP is the sum of two pressures: the pressure required to force the gas through the resistance of the airways and the pressure of the gas volume as it fills the alveoli at the end of inspiration. During pressure-targeted ventilation, the PIP is determined primarily by the target pressure set on the ventilator. PIP is used to calculate dynamic compliance. (17)

In our study, the mean peak airway pressure on day 1 was 34.89 ± 4.43 cmH₂O in group I and 31.08 ± 4.57 cmH₂O in group II, on day 2 it was 34.38 ± 5.30 cmH₂O in group I and 30.16 ± 5.24 cmH₂O in group II, on day 3 it was 33.22 ± 5.88 cmH₂O in group I and 28.46 ± 5.82 cmH₂O in group II, there was statistically significant decrease (P<0.001) in the mean peak airway pressure in the PRVC group compared to BIPAP group in the first 3 days.

These findings are supported by what was found by Akbaba et al (15) who reported significant decrease (P < 0.025) in peak airway pressure in PRVC group in comparison with pressure control ventilation during laparoscopic cholecystectomy.

In contrast to this, Alvarez et al (14) found no statistically significant differences in peak airway pressures between PRVC group 26.1 ± 8.2 cmH₂O and PCV group 25.9 ± 8.4 cmH₂O and also Richard et al (15) found no differences in peak airway pressures between PRVC group 22 ± 9 cmH₂O and PCV group 23 ± 8 cmH₂O. These different results may be due to low number of studied patients (10 patients) with shorter duration (1 hour) for each ventilation mode with different lung pathology.

The beneficial effects of reduced peak airway pressure concerning lung injury have been attributed to a
simultaneous reduction in peak alveolar pressure and, consequently, less alveolar distension. \(^{14}\)

The mean airway pressure represents the average pressure recorded during the respiratory cycle. Monitoring of mean airway pressure is helpful in monitoring the benefits and side effects of positive pressure ventilation (PPV), and it closely parallels the mean alveolar pressure. Newer ventilators automatically calculate and display mean airway pressure which affected by PIP, PEEP; inspiratory time and RR. inspiratory flow patterns and modes also can influence mean airway pressure. The mean airway pressure is important to tissue oxygenation and affects both lung volumes and cardiac output. \(^{17}\)

In the current study, The mean value of mean airway pressure on day 1 was 16.91 ± 2.59 cmH\(_2\)O in group I and 14.76 ± 2.08 cmH\(_2\)O in group II, on day 2 it was 16.23 ± 2.97 cmH\(_2\)O in group I and 14.38 ± 2.94 cmH\(_2\)O in group II, on day 3 it was 16.32 ± 2.67 cmH\(_2\)O in group I and 14.27 ± 2.81 cmH\(_2\)O in group II. There was statistically significant decrease in the mean airway pressure in the first 3 days in the PRVC group compared to the BIPAP group. In agreement with our study, Samantaray et al. \(^{12}\) found that there was statistically significant decrease (P=0.001) in the mean airway pressure in the PRVC group with mean value 7.7 ± 0.5 cmH\(_2\)O compared to the PCV group with mean value 8.6 ± 0.8 cmH\(_2\)O at 2 hours of ventilation.

This can be explained by the fact that, although both PCV and PRVC use a decelerating flow pattern which has been shown beneficial in acute lung injury \(^{15}\) PRVC combines the benefits of decelerating flow of PCV with a safety of a volume guarantee at a lowest possible titrated inspiratory pressure.

In contrast to our study, Alvarez et al. \(^{14}\) found no differences in mean airway pressures between PRVC with mean value 12.2 ± 3.8 cmH\(_2\)O and PCV group with mean value 12.3 ± 3.8 cmH\(_2\)O after one hour of ventilation.

In the current study, as regards static compliance, inspiratory resistance and rapid shallow breathing index there was no statistically significant difference between the two groups. Also as regards auto PEEP and work of breathing (WOB) there was no statistically significant difference between the two groups. In agreement with our study is the study of Richard et al. \(^{16}\) who found that there was no statistically significant difference between PRVC group compared to the PCV group as regards WOB and PIP.

In our study, The mean value of mean airway pressure was statistically significant difference between PRVC group compared to BIPAP group without significant difference in PaO\(_2\), PSpO\(_2\), PaCO\(_2\). These findings are supported by what was found by Samantaray et al. \(^{12}\) who reported significant increase in hypoxic index in the PRVC group compared to the PCV group which was attributed to significantly low mean airway pressure in the PRVC group at 2 h of ventilation. This beneficial effect of PRVC mode was continued till 12 h post extubation and reflected as higher PaO\(_2\)/FiO\(_2\) ratio in the PRVC group compared to the PCV group. This can be explained by the fact that, PRVC combines the benefits of decelerating flow of PCV with a safety of a volume guarantee at a lowest possible titrated inspiratory pressure. \(^{19}\)

In agreement with our study is the study of Sachdev et al. \(^{20}\) which concluded that PRVC had improved oxygenation with improvement of PaO\(_2\) and PaO\(_2\)/FiO\(_2\) in initial stages of ventilation. Similarly AbouShehata et al. \(^{21}\) found that there was significant improvement of arterial blood gases after 1 h, 2 h, 2nd day and 3rd day of using PRVC with gradual reduction of the used FiO\(_2\) in the same period.

In contrast to our study, Alvarez et al. \(^{14}\) found no difference in hypoxic index between PRVC and PCV group and also found no statistically significant difference between PRVC group compared to the PCV group as regards PaO\(_2\) and PaCO\(_2\). The selection of patients with heterogeneous pathologies and different severity grades of pulmonary lesion probably influenced these results. Some kinds of lung injury may possibly benefit more from PRVC.

In the present work, as regards sedation score using Ramsay Scale and midazolam infusion rate there was no statistically significant difference between PRVC group compared to the BIPAP group. In agreement with our study is the study of Sigismond et al. \(^{21}\) who found that there was no statistically significant difference between PRVC group compared to the other group as regards sedation score and midazolam infusion rate.

Patient–ventilator dyssynchrony is referred to as the uncoupling of the mechanical delivered breath (ventilator) and neural respiratory effort (patient). It is commonly associated with all the conventional modes of assisted mechanical ventilation and influenced by factors related both to the patient and the ventilator. \(^{22}\) Patient–ventilator dyssynchrony imposes an additional burden on the respiratory system and may increase the morbidity of critically ill patients. Inspection of pressure, flow and volume waveforms – provided by the modern ventilators – represents a valuable tool for the physician to recognize and take the appropriate action to improve patient–ventilator synchrony. \(^{23}\)
In our study there was no statistically significant difference between the two groups all over the five days as regards Patient ventilator dysynchrony. In agreement with our study is the study of Richard et al. who found that there was no statistically significant difference between PRVC group compared to the PCV group as regards Patient ventilator dysynchrony.

Prolonged mechanical ventilation and endo-tracheal intubation leads to impairment of the normal protective reflexes of the respiratory tract with increased incidence of ventilator-associated pneumonia with a high mortality rate. 

In the current study there was no statistically significant difference between the two groups as regards mortality & ventilator associated pneumonia and also as regards ICU & ventilator days there was no statistically significant difference between the two groups. In agreement with our study is the study of AbouShehata et al. who found that there was no statistically significant difference as regards ICU & ventilator days between the two groups.

References

Armstrong B.W., Machntyre N.R., Pressure-controlled, inverse ratio ventilation that avoids air trapping in the adult respiratory distress syndrome, Crit. Care Med. 1995;23:279–85