Short communication

Prone position and APRV for severe hypoxemia in COVID-19 patients: The role of perfusion

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Abstract

There have been confusion and contradiction on how to best manage patients with acute respiratory failure secondary to Corona virus disease-2019 (COVID-19). Recent report suggested two different phenotypes of patho-physiology (type L and type H). Type L is characterized by low elastance and low ventilation-perfusion mismatch ratio (V/Q), while type H is more consistent with the classic acute respiratory distress syndrome (ARDS) characterized by high elastance and increased right to left shunt. The role of perfusion deficits has been clearer with the discovery of micro and macro vascular thrombi in the lung vascular endothelium. Prone position has gained interest in research and guidelines as a maneuver capable of improving ventilation and perfusion. Airway pressure release ventilation (APRV) can theoretically improve hypoxemia due to ventilation/perfusion mismatch in patients with COVID-19 compared to other conventional strategies. From this perspective, we may have to consider perfusion as the major problem in the disease process more than just ventilation.
More studies are required to explore the role of perfusion and the different ventilatory strategies to best manage those patients.

Key Words: airway pressure release ventilation; APRV; prone position; COVID-19; SARS-CoV-2.

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Introduction

Since December 2019, the death toll from SARS-Cov-2 (COVID-19) has been increasing rapidly and claiming almost half a million lives globally to this moment. Ventilatory management of this novel disease has been controversial and associated with high mortality. The surviving Sepsis Campaign guidelines suggested the use of low tidal volume strategies with high levels of positive end-expiratory pressure (PEEP) [1] in managing critically ill COVID-19 patients. On the other hand, Gattinoni and colleagues suggested "gentle ventilation with low PEEP levels" might be more suitable for COVID-19 patients given that its patho-physiology might be different from the classic acute respiratory distress syndrome (ARDS). [2] Similarly other authors [3] suggested the use of low PEEP levels to below 10 cmH_2O as higher levels can cause over distention in alveoli consequently further worsening perfusion.

There are two phases or phenotyes in COVID-19, which were recently described as type L and type H. Type L is characterized by low elastance, low V/Q ratio, low lung weight, and low lung recruitability. Type H is more consistent with the classic ARDS which characterized by high elastance, increased right to left shunt, high lung weight, and high lung recruitability. The reported the respiratory system compliance of 50.2 ± 14.3 ml/cmH2O, is higher than the classic ARDS indicating preserved lung gas volume and a shunt fraction of 0.50 ± 0.11 that is also higher than the classic ARDS patients and this may be reflecting the type L. Since type L has good compliance and low V/Q ratio, the same authors have questioned if this disease should be considered as ARDS [4] and if applying high PEEP may further impede perfusion, worsening the V/Q mismatch and thus oxygenation.

On the other hand, hypercoagulability has been increasingly reported in COVID-19 patients, with coagulation profiles showing increased levels of D-dimers, thrombin and fibrinogen levels. Micro-thrombi and endothelial damage have been reported on autopsy of deceased patients. [3,5] Macro thrombosis in the form of deep venous thrombosis (DVT) and pulmonary embolisms (PE) have also been reported [6]
The reported effectiveness of full anticoagulation [7] and even of systemic thrombolytic therapy confirm the theory of perfusion deficits is an important contributor to the hypoxemia in this disease.

Recent guidelines from the National Institute of Health [8] have emphasized the role of hypercoagulability during COVID-19 infection. Additionally, guidelines by International Society of Thrombosis and Haemostasis (ISTH) [9] and the American Society of Hematology [10] for the management of coagulopathy and venous thromboembolism in COVID-19 patients were published.

The society of critical care guidelines [1] and others [11] have reasonably suggested the use of the prone position in mechanically ventilated and non-mechanically ventilated patients to enhance lung recruitment and decrease alveolar instability and hyperinflation. Prone position has also proven to improve the gravitational lung perfusion, ventilation-perfusion mismatch, and right ventricular function in ARDS. [12]

To our knowledge, there is no published data or research on the use of airway pressure release ventilation (APRV) in patients with COVID-19. However, the APRV network [13] has published guidelines on the use of APRV as rescue strategy during the COVID pandemic. APRV unique mechanism of action for allowing spontaneous unrestricted breaths on top of the mandatory breaths (Pressure controlled intermediate controlled mode) has been proven to improve ventilation-perfusion matching, cardiac output, hemodynamics, decreased intrapulmonary shunt, extra-vascular lung water and decreased dead space, along with alveolar recruitment. [14]

Based on these previous reports, prone position and APRV theoretically improve the V/Q mismatch of the lung and may have an important role in supporting COVID-19 patients with hypoxemia and respiratory failure due to V/Q mismatch.

From this perspective, it is getting clearer that lung perfusion is a major problem of this disease, and it is time that we start to consider the role of perfusion more than just ventilation. Further studies are warranted to confirm this suggestion.

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