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EDITORIAL

Physiology and evidence join in favor of prone decubitus☆

Fisiología y evidencia se unen en favor de la posición de decúbito prono

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In this issue of *Medicina Intensiva*, Mora-Arteaga et al.[1] present a systematic review and metaanalysis involving the final inclusion of 7 randomized clinical trials (2119 patients) in which an analysis was made of the effect of changing the position to prone (ventral) decubitus in patients with acute respiratory distress syndrome (ARDS). Specifically, the study aimed to determine whether the change in position in this patient population has an impact upon an outcome as important as mortality–independently of other outcomes such as the time on mechanical ventilation, the duration of stay, or possible improvement of the oxygenation parameters. Although the overall studies did not suggest a decrease in mortality, the analysis by subgroups did reveal a significant decrease in this outcome. In effect, a significant decrease was noted in mortality risk associated to prone decubitus in patients subjected to low tidal volume ventilation (OR 0.58; 95% CI: 0.38–0.87; $p = 0.009$, I2 33%), prolonged pronation (OR 0.6; 95% CI 0.43–0.83; $p = 0.002$, I2 27%), implementation in under 48 h after onset of the disease condition (OR 0.49; 95% CI 0.35–0.68; $p = 0.0001$, I2 0%) and severe hypoxemia (OR 0.51; 95% CI 0.36–1.25; $p = 0.0001$, I2 0%).

These results can be well explained from a purely physiological perspective. The physiopathology of ARDS fundamentally involves alveolar-capillary membrane damage with lung edema, surfactant loss and the formation of high-density areas (occupied and atelectatic alveoli), which as a result of the action of gravity are mainly located in the posterior lung regions. The release of inflammatory mediators moreover cause bronchoconstriction, the formation of emboli, pulmonary artery vasoconstriction and, ultimately, lung fibrosis.[2] Apart from these more traditional phenomena, the changes inherent to the lung parenchyma repair process also exert an effect.[3,4] In any case, all these phenomena essentially give rise to worsened gas exchange secondary to a loss of aeration of the dependent lung zones.

Based on physiological and physiopathological principles, ''lung protecting'' ventilatory strategies were developed which when applied on either a preventive or therapeutic basis in severe ARDS result in a decrease in lung collapse and overdistension. These strategies fundamentally involve the application of low tidal volumes (or at least volumes lower than those used in routine clinical practice) and the adoption of measures destined to increase residual functional capacity (RFC) and lung volume – though in actual clinical practice mortality remains high among patients with ARDS.[5,6]

All these strategies are fundamentally based on ''ideal'' lung size. However, Amato et al.[7] recently have indicated that such strategies must be applied individually and should be optimized according to lung compliance and the ratio between the applied tidal volume and lung compliance–i.e., the strategies should be based not so much on reduction of the tidal volume according to ''ideal'' lung size but on ''functional'' lung size. In clinical practice it is not easy to estimate transpulmonary pressure (which is the pressure that truly drives ventilation), though we do have variables that are able to estimate this parameter, such as distension pressure (the difference between pause pressure

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and total PEEP). In this regard, the study published by Amato et al.[7] showed a decrease in distension pressure to be associated to improved prognosis among patients with ARDS.

It has been known since the 1960s that the prone position improves oxygenation in patients with ARDS. Furthermore, some of the physiological mechanisms in prone decubitus in patients with ARDS facilitate the application of protective ventilation strategies–thereby securing a dual objective. The main mechanisms are the following[8,9]:

- *Increased RFC*: Patients who respond in the prone position experience a regional increase in RFC in the dorsal areas due to alveolar recruitment, while at the same time RFC is minimized in the ventral or anterior regions. The end result is a similar global RFC in the prone and supine position, though aeration of dependent lung zones is achieved.
- *Increased respiratory system elasticity*: This refers to the changes in global respiratory system distensibility (pulmonary and thoracoabdominal cavity), on which lung ventilation is dependent. Increased global elasticity has been observed in the prone position.
- *Increased diaphragmatic mobility*: Mechanical ventilation is characterized by cephalad displacement of the diaphragm, resulting in lesser excursion with inspiration in the dorsal regions. Such diaphragmatic motion is improved in the prone position.
- Reduction of the weight of the heart upon the lungs, thereby favoring pulmonary expansion.
- The effects of recruitment maneuvering and PEEP application are improved. Seeking optimum PEEP is often futile, though it seems clear that in cases of ARDS higher PEEP levels should be used (15–20 cm H_2O), paying special attention to lung compliance and the hemodynamic situation. We must know the degree of lung recruitment in patients with ARDS (in order to avoid atelectrauma effects) and balance it with an adequate tidal volume (in order to avoid overdistension phenomena).
- The hemodynamic profile is also improved, reducing right ventricle overload, since the transpulmonary pressure and PEEP level are also reduced while maintaining recruitment capacity–thereby protecting right ventricle function.

In sum, both the physiology and the scientific evidence obtained from clinical trials and metaanalyses such as that published by Mora-Arteaga et al. suggest that the current gold standard for the ventilation of patients with severe ARDS should include measures for reducing the tidal volume (adapted to its effects upon lung mechanics, and taking lung functional volume and compliance into account), the maintenance of an adequate RFC, and close monitoring of lung mechanics and its relation to right ventricle function. This strategy must include patient positioning in prone decubitus. In future, other strategies should be compared with this ventilation gold standard in order to establish their possible efficacy and efficiency, and it might prove necessary to use adequate regional lung ventilation monitoring techniques.[10] This is all the more important when considering that we even must question the efficacy of the formulas used to estimate ideal weight (this being the basis for estimating the adequate tidal volume for each patient), where the differences that can vary by as much as 25%.[11]

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Conflicts of interest

The authors declare that they have no conflicts of interest in relation to the present document.

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