LETTER TO THE EDITOR

Author's Response to Trendelenburg Ventilation in Acute Respiratory Distress Syndrome: Should We Do More than Proning?

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Response:

Thank you for reading our research work and responding to it. We appreciate your point of view in looking into this new concept, and we have tried to explain your queries in the possible ways.

We read with interest the article by Kodamanchili et al.,[1] describing the use of Trendelenburg position for the improvement of respiratory mechanics in acute respiratory distress syndrome (ARDS). A 25-year-old lady with ARDS benefited from the head-down position with an improvement in delivered tidal volume (TV), CO_2 removal, and improvement in static lung compliance. While the observation is interesting, the theories suggested by the authors to explain the same need further examination.

The authors suggest that the lower functional residual capacity (FRC) caused by cranial displacement of the diaphragm and cephalad migration of the abdominal contents would translate to a higher TV when the lungs are inflated to total lung capacity (TLC). The TLC is the sum of the FRC, TV, and inspiratory reserve volume (IRV). In ARDS, we ventilate patients with TVs of 4–6 mL/kg. Even in the case described, the improvement of lung compliance resulted in a TV of 300–320 cc, which is not anywhere near the lungs getting inflated to TLC. Therefore, improvement in ventilation due to the lungs getting inflated to TLC seems unlikely.

(The increase in TV is generally expected in patients with poor lung compliance with a difficulty in achieving even 4–6 mL/kg TV, and as explained in the figures, we assumed that the extra gain in TV could be from rearrangement of lung volumes especially FRC keeping the TLC constant).

While Trendelenburg's position leads to a decrease in FRC, it will not lead to an improved TV delivery for the same pressures, unless there is an associated improvement in lung compliance. Trendelenburg's position led to a worsening in lung compliance and resistance in patients ventilated with 15-degree head-down tilt in elective surgery.[2] In the study cited by Kodamanchili et al., Trendelenburg's position decreased the total lung compliance by 17% when the head-down position reached 20 degrees in anesthetized children.[3] However, these were subjects with otherwise normal lungs and not the stiff lungs we frequently encounter in ARDS.

(Yes, as you rightly mentioned sir/madam, but no proper study was done till now in ARDS lungs, so we too clearly don't know what could have caused the improved lung performance, for which we assumed few theories as explained).

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The Parachute theory proposed by the authors regarding reconfiguration of the diaphragm in Trendelenburg position improving mechanical efficiency is seen in spontaneously breathing patients with low cervical spinal cord injury.[4] While ARDS patients on mechanical ventilation may have varying degrees of diaphragmatic thinning and dysfunction, they are physiologically different from patients with spinal cord injury. The benefit of diaphragmatic reconfiguration in head-down could benefit only if the patients were spontaneously breathing and not when they are paralyzed by neuromuscular blockers.

(Yes, it was in spontaneously breathing patients, which might also be playing some role in ventilated ARDS patients and needs further validation mentioned in our paper).

The question is why did the authors observe such improvement with Trendelenburg's position. Rezoagli et al.[5] described a case of 63-year-old lady who showed similar improvement in lung compliance (from 12 to 14 mL/cm of H_2O) with Trendelenburg position. They used EIT and found that head-down position from supine led to a decrease in overdistention of the lung by 21%, and an improvement in stress index of the lung. Essentially, the decrease in end-expiratory lung volume (EELV) in Trendelenburg's position resulted in the lungs moving to a more compliant position on the pressure–volume curve. This led to a decrease in tidal overinflation, which was reflected by an improvement in compliance and driving pressures. The decrease in lung overdistension was seen mainly in the nondependent lung areas. A recent observational study by Marrazzo et al.[6] noted similar

improvement in lung compliance in 20 patients with coronavirus disease-2019 (COVID-19)-related ARDS when the head position was lowered from 40 degrees head-up to a flat-supine position. Based on these observations, the "rigid chest wall" theory suggested by Kodamanchili et al. may have some merit, although the amount of lung recruitment might vary between dependent and nondependent lung zones.

Therefore, ARDS patients showing improvement in respiratory mechanics following head-down position should alert us to the possibility of tidal overinflation. This could serve as an indicator for PEEP titration with significant improvement in compliance in head-down position indicating a need to reduce PEEP. This appears to be an exciting area of research for optimizing ventilation in ARDS patients.

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