Prone Position: A Strategy in Expansion?

The use of prone positioning has been in popularized in the lay press and in academic literature with increasing frequency recently. There are several mechanisms of actions that contribute to improvement in gas exchange for patients in the prone position. First, transpulmonary pressures are lowest in nondependent regions of the lung, which, in prone positioning, is the dorsal aspect.[1] Second, the weight of the heart and other mediastinal structures, as well as abdominal structures, is assumed by the sternum in the prone position, decreasing the compressive forces on the dorsal lung region.[2] These both lead to recruitment of alveoli in the dorsal aspect of the lung. A greater percentage of lung tissue and pulmonary vasculature lie in the dorsal region.[3] Therefore, this alveolar recruitment contributes to significant improvement in ventilation to perfusion matching and gas exchange. The respiratory system compliance (ie, lungs and chest wall) may be affected by prone positioning, and lung compliance improves with recruitment. However, counteracting this is a reduction in chest wall compliance.[4,5] Clinicians should re-evaluate plateau pressure and tidal volume, checking for lung recruitment, as well as the PEEP required, as overdistention may occur when moving from a supine position to a prone position.

Prone position has been studied for decades, with initial research focusing on the effect of prone positioning on survival rates of patients with ARDS. Many randomized controlled trials[6-8] have reported that prone positioning improves survival when used early, for long durations (ie, $>$ 16 h/d), and when paired with a low tidal volume mechanical ventilation strategy.[9] The recent pandemic related to the SARS-CoV-2 novel corona virus (COVID-19) has spurred further research into the role of prone positioning for these severely hypoxemic patients. However, much of this literature has conflicting results. Thompson and colleagues[10] looked at nonintubated subjects diagnosed with COVID-19 and showed an improvement in oxygen saturation with a reduction in intubation rate. Ferrando et al[11] assessed a similar cohort, and their results indicated no reduction in the number of subjects requiring intubation and a significant delay in the time to intubation, perhaps contributing to self-induced lung injury. Some ongoing randomized clinical trials are addressing the need of invasive mechanical ventilation (eg, NCT04350723 and NCT04347941).

SEE THE ORIGINAL STUDY ON PAGE 724

In this issue of RESPIRATORY CARE, Wiart et al[12] report on a retrospective review of 39 intubated subjects diagnosed with moderate to severe ARDS (some related to COVID-19 and some not) who underwent prone positioning. They assessed whether prone positioning was as successful if subjects were spontaneously breathing, specifically under pressure support ventilation, as subjects who were under full volume control ventilation. The results showed a similar increase in P_{aO_2}/F_{IO_2} in both groups, but there was a significantly lower use of neuromuscular blocking agents in the pressure support ventilation cohort. The authors commented on the clinical implications of this reduction in neuromuscular blocking agents and the use of spontaneous modes of ventilation, such as decreased sedation requirements, preservation of muscle function, and early mobilization, which are important goals in most ICUs.

As discussed by Wiart and colleagues,[12] prone positioning can be considered a low-cost treatment with potentially significant benefits on survival. No intricate equipment is necessary to accomplish the position change, simply a team of health care workers. Clinicians should, however, be cautioned in considering prone positioning a benign procedure. Kallet[3] detailed many complications of prone positioning, including endotracheal tube dislodgement, selective mainstem intubation, intravenous/intraarterial access dislodgement, facial edema, brachial plexus injury, and pressure-related skin injury. If dislodgement of a tube or a line is not recognized or is not addressed in a relatively short time frame, permanent damage or even patient death can occur. Wiart et al[12] did not note statistically significant differences in any specific complication between the pressure support ventilation and volume control ventilation groups. However, complications such as premature termination of prone positioning, cardiac arrest, unplanned extubation, and mainstream bronchus intubation were described in the pressure support ventilation group only. Perhaps, if the sample size were larger, statistical differences may emerge.

We believe this trend is important. Neuromuscular blocking agents may provide some control for clinicians

The authors have disclosed no conflicts of interest.

Correspondence: Carolyn J La Vita MHA RRT, Massachusetts General Hospital, Respiratory Care, Warren 12, 55 Fruit St, Boston, Massachusetts 02114. E-mail: clavita@mgh.harvard.edu.

DOI: 10.4187/respcare.09131

during the maneuver and may prevent some complications. Spontaneously breathing patients may be awake and aware to some degree, and turning them onto their stomach while hypoxic and dyspneic is no easy feat. Patients may react negatively to this change in position and, without neuromuscular blocking agents, may contribute to the likelihood of complications.

Furthermore, the low cost of prone position may be lost if injuries to staff occur without improved patient outcomes. Guérin and colleagues[8] attributed their outcome success and lack of complications to the teamwork of the staff and the familiarity with the procedure because prone positioning had become part of their routine treatment for ARDS several years prior. During the COVID-19 pandemic, many centers worldwide developed proning teams, which typically consisted of a dedicated group of individuals from various role groups who underwent extensive training and practice to ensure mastery of the maneuver.[13]

Prone positioning is here to stay. The data supporting its use for patients diagnosed with moderate to severe ARDS is undeniable. However, we need more concrete evidence on outcome measures such as intubation and survival rates in patients diagnosed with COVID-19 and those allowed to breathe spontaneously.

Carolyn J La Vita
Department of Respiratory Care
Massachusetts General Hospital
Boston, Massachusetts

Roberta Ribeiro De Santis Santiago
Lung Rescue Team
Massachusetts General Hospital
Boston, Massachusetts

REFERENCES

1. Piraino T. Prone positioning in moderate ARDS. AARC Times 2018:5-11.
2. Albert RK, Hubmayr RD. The prone position eliminates compression of the lungs by the heart. Am J Respir Crit Care Med 2000;161 (5):1660-1665.
3. Kallet H. A comprehensive review of prone position in ARDS. Respir Care 2015;60(11):1660-1687.
4. Pelosi P, Tubiolo D, Mascheroni D, Vicardi P, Crotti S, Valenza F, Gattinoni L. Effects of the prone position on respiratory mechanics and gas exchange during acute lung injury. Am J Respir Crit Care Med 1998;157(2):387-393.
5. Guérin C, Albert RK, Beitler J, Gattinoni L, Jaber S, Marini JJ, et al. Prone position in ARDS patients: why, when, how and for whom. Intensive Care Med 2020;46(12):2385-2396.
6. Mancebo J, Fernández R, Blanch L, Rialp G, Gordo F, Ferrer M, et al. A multicenter trial of prolonged prone ventilation in severe acute respiratory distress syndrome. Am J Respir Crit Care Med 2006;173 (11):1233-1239.
7. Taccone P, Pesenti A, Latini R, Polli F, Vagginelli F, Mietto C, et al. Prone positioning in patients with moderate and severe acute respiratory distress syndrome: a randomized controlled trial. JAMA 2009;302 (18):1977-1984.
8. Guérin C, Reignier J, Richard J, Beuret P, Gacouin A, Boulain T, et al. Prone positioning in severe acute respiratory distress syndrome. N Engl J Med 2013;368(23):2159-2168.
9. Beitler JR, Shaefi S, Montesi SB, Devlin A, Loring SH, Talmor D, Malhotra A. Prone positioning reduces mortality from acute respiratory distress syndrome in the low tidal volume era: a meta-analysis. Intensive Care Med 2014;40(3):332-341.
10. Thompson AE, Ranard BL, Wei Y, Jelic S. Prone positioning in awake, nonintubated patients with COVID-19 hypoxemic respiratory failure. JAMA Intern Med 2020;180(11):1537-1539.
11. Ferrando C, Mellado-Artigas R, Gea A, Arruti E, Aldecoa C, Adalia R, et al. Aware prone positioning does not reduce the risk of intubation in COVID-19 treated with high-flow nasal oxygen therapy: a multicenter, adjusted cohort study. Crit Care 2020;597(4): 1-11.
12. Wiart A, Wittebole X, David G, Maerckx G, Laterre P, Gerard L. Prone positioning in spontaneously breathing patients with moderate or severe ARDS under invasive mechanical ventilation: a monocentric retrospective study. Respir Care 2021;66(4):724-732.
13. Short B, Parekh M, Ryan P, Chiu M, Fine C, Scala P, et al. Rapid implementation of a mobile prone team during the COVID-19 pandemic. J Crit Care 2020;60:230-234.