

Pronation in The Management of Patients with ARDS by COVID-19 Cohort Study

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Abstract

Background: Since the onset of the COVID-19 pandemic, knowledge of the different stages of the disease has increased. In the most severe cases, alveolar collapse, pulmonary consolidation and imbalance in the relationship between ventilation and perfusion are observed, perpetuating hypoxemia. We have controversial evidence of the use of the prone position, with improved oxygenation and decreased mortality.

Objective: To present our experience on the effectiveness of the prone position in the management of patients with ARDS due to COVID-19 under mechanical ventilation. Material and Methods: Retrospective cohort study in patients with severe COVID-19 under mechanical ventilation with $pO_2/FiO_2 < 150$ mmHg, who were managed in a prone position.

Results: Sixty-two mostly male individuals were analyzed. Only 4.8% were normal weight, the rest were overweight/obese, 17.7% were morbidly obese. The median pO_2/FiO_2 at ICU admission was 84 with a statistically significant improvement at extubation ($p < 0.001$). The percentage of death was 68.8%.

Conclusions: Our study identified that prone position was able to achieve an improvement in PO_2/FiO_2 ratio in mechanically ventilated patients secondary to COVID-19.

Keywords: COVID-19, Complications, prone position, ARDS, Treatment.

1. Introduction

In many patients affected by COVID-19, serious disease characterized by progressive hypoxemic respiratory failure occurs, which may require invasive mechanical ventilation. For those intubated patients with moderate to severe acute respiratory distress syndrome, prone positioning has demonstrated to be an effective intervention to improve oxygen levels and reduce mortality [1]. Prone positioning has been associated with improved oxygenation in observational studies of non-intubated patients with acute respiratory distress syndrome and, more recently, in patients with

COVID-19 requiring mechanical ventilation [2].

Before the current COVID-19 pandemic, the use of prone positioning in patients with acute respiratory failure while they were awake had been investigated as a way to avoid endotracheal intubation and reduce the necessity of intensive care unit (ICU) admission. Given the high number of patients with COVID-19 requiring mechanical ventilation, the prone position technique has been widely implemented to improve oxygen levels [3].

The prone position improves the ventilation/perfusion ratio and the recruitment of the dorsal segments of the lungs, which allows the opening of the dorsal alveoli which were collapsed, thus improving gas exchange and oxygenation. It has been reported in patients with severe acute respiratory distress syndrome (ARDS), who received mechanical ventilation, that those who were positioned prone had a lower mortality rate [4].

Even though there are studies that suggest the usefulness of the prone position, most authors conclude that it is difficult to propose this strategy with a high degree of quality evidence due to the high level of uncertainty in the published studies, high risk of bias, low level of evidence, non-standardized prone position regimen and different mode of ventilation in all the included studies [3].

Studies focused on evaluating the effects of prone positioning in patients under mechanical ventilation with ARDS, have shown a decrease in mortality and in the number of days of mechanical ventilation; however, the studies published thus far show discordant results between this intervention and mortality, and there is insufficient information to establish an optimal period of time to obtain and maintain favorable results with this management strategy.

Considering the above, and to contribute to the generation of evidence to facilitate decision-making, we would like to present our experience in the prone position management of patients intubated by COVID-19.

2. Material and Methods

A retrospective cohort study was performed in patients of the Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado. This study was authorized by an Ethics and Research Committee with registration number 126/2003 and adhered to the

Declaration of Helsinki and Good Clinical Practice Guidelines for its execution. All patients who were admitted to the Intensive Care Unit with a diagnosis of severe COVID-19 under mechanical ventilation, with a $pO_2/FiO_2 < 150$ mmHg were included. Patients with increased intracranial pressure, unstable spinal cord injuries, major thoracic surgery, pelvic or long bone fractures were not considered candidates for prone positioning. Among the subjects who did satisfy the criteria, a 16-hour daily pronation schedule was applied. The general characteristics of the population were recorded and the evolution of the clinical status was identified in four times (16 hours minimum): 1) pO_2/FiO_2 at ICU admission, 2) pO_2/FiO_2 at the beginning of pronation, 3) pO_2/FiO_2 at the end of pronation and 4) pO_2/FiO_2 at extubation; finally the outcome of each of the subjects studied was reported according to their recovery or death. All data were analyzed with the statistical program SPSS ver 26 in Spanish. For the evaluation of improvement, pO_2/FiO_2 was considered under a multivariate analysis.

3. Results

A cohort of 62 individuals was analyzed, most of them were male (61.3%) vs a female percentage of 38.7% (Table I), only 4.8% of the population had a normal weight, the rest were distributed in overweight (46%), obese (30.6%) and morbidly obese (17.7%) patients. The most frequent comorbidity was COPD (93.5%), followed by alcoholism (90.3%) and smoking (83.9%). Type 2 diabetes was present in 66.1% of the population, and hypertension in 54.8% (Figure I). The pO_2/FiO_2 was registered at patient admission to ICU with a median of 84 (53.5 - 91.5; q25-q75), subsequently identified at the beginning and end of prone 75 (63-92; q25-q75) and 134 (92-178; q25-q75) respectively, finally at the time of extubation the median pO_2/FiO_2 was 230.5 (198 - 260.7; q25-q75). Between ICU admission and the time of extubation, there were statistically significant differences in pO_2/FiO_2 ($p < 0.001$) (Figure II). The percentage of death was 68.8% (Figure III).

N=62	n	%
Gender		
Female	24	38.7
Male	38	61.3
Nutritional status		
Normal weight	3	4.8
Overweight	29	46
Obesity	19	30.6
Morbid obesity	11	17.7

Table I. General characteristics of patients admitted to ICU with severe COVID-19 and need for orotracheal intubation.

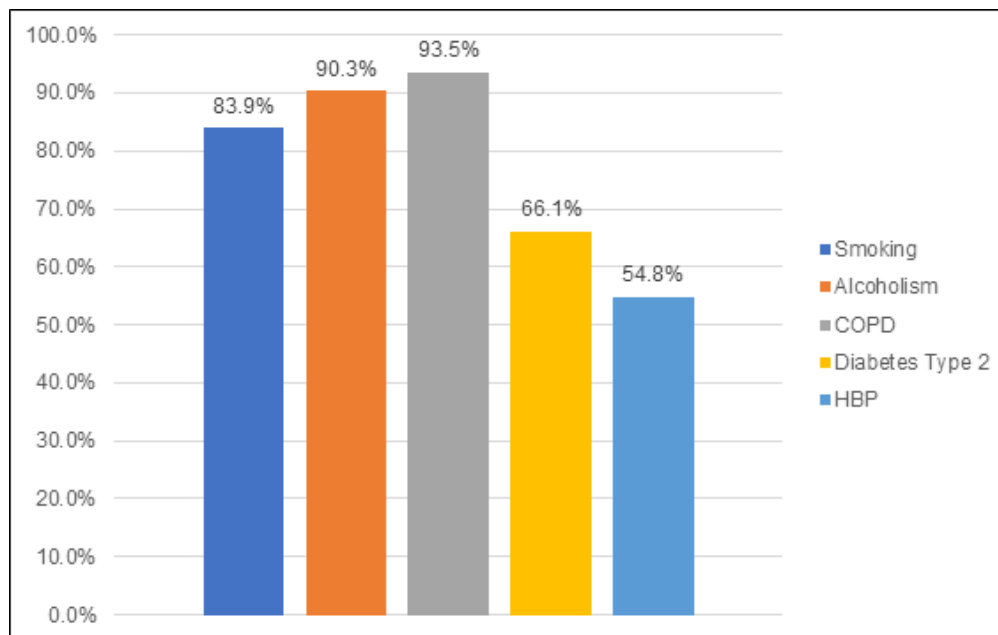


Figure I. Comorbidities present in the population with acute COVID-19 admitted to the ICU.

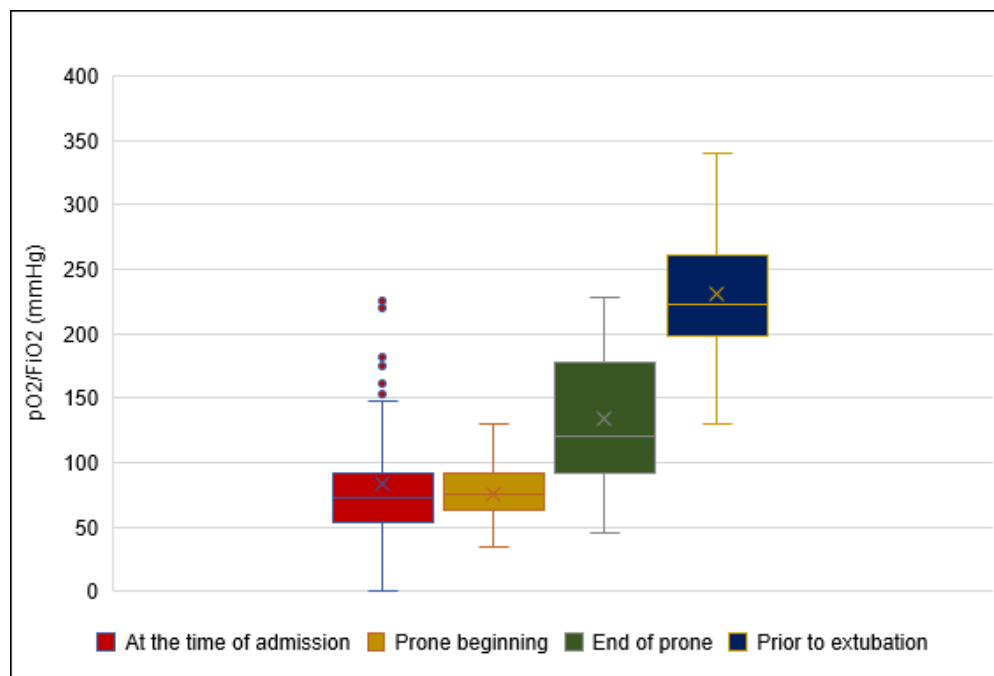


Figure II: pO₂/F_iO₂ ratio before and after the pronation maneuver in the intubated patient

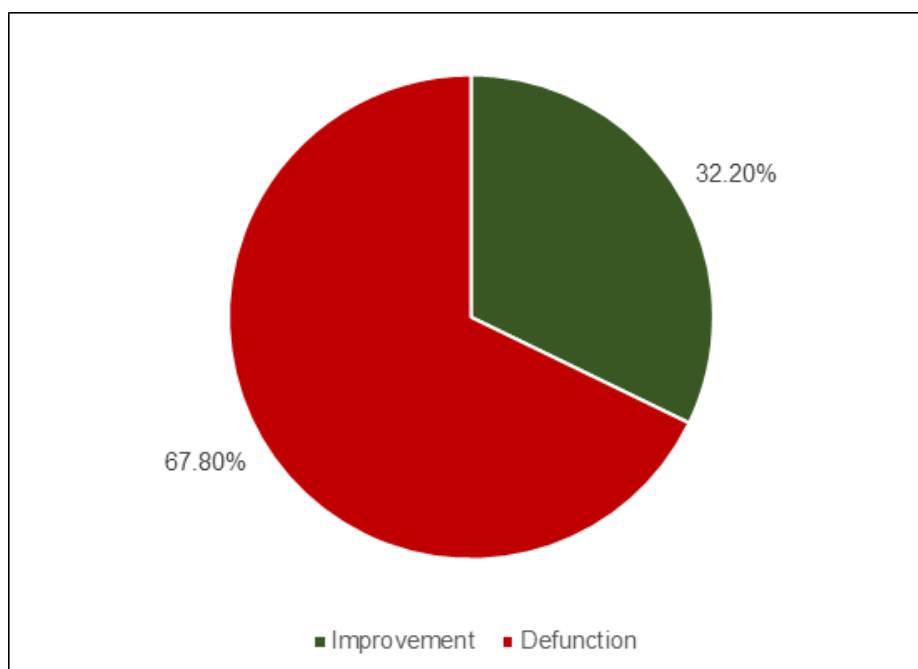


Figure III. Outcome of patients with a diagnosis of acute COVID-19 with assisted ventilation and prone management.

4. Discussion

In this study, we have identified some noteworthy aspects, especially regarding the good results obtained once the prone position was used as a strategy to improve oxygenation in patients under mechanical ventilation for ARDS secondary to COVID-19 infection. These results coincide with those reported by Johnson et al. and Jayakumar et al. who ran two small pilot trials (with $n=30$ and $n=60$ patients, respectively) to evaluate the feasibility of prone positioning. However, these trials were not powerful enough to demonstrate significant improvements in oxygenation or mortality [5, 6].

On the other hand, Stalla Alver et al. performed a retrospective study to evaluate respiratory monitoring by mechanical power (MP) and its relationship with mortality in patients with COVID-19-related ARDS under mechanical ventilation strategies and prone position [7]. Consistent with our results, they found a statistically significant difference in MP measurements between survivors and nonsurvivors only in the last prone position ($p < 0.001$).

Okin D et al. on the other hand, studied the results of the prone position with very favorable results, in addition to analyzing two modalities of the technique, intermittent and continuous [8]. Among COVID-19 intubated patients who received PPV, prolonged PPV was associated with reduced mortality. Prolonged PPV was associated with fewer pronation and supination events and a small increase in facial edema rates. The results of Okin D et al. suggested prolonged PPV as a safe and effective strategy to reduce mortality in patients intubated with COVID-19.

The prone approach in ARDS considers several pathophysiological aspects, starting with the ventilation/perfusion relationship; considering that the architecture of the airways and pulmonary blood vessels share certain asymmetries in their respective angles and branch diameters, conferring a heterogeneous distribution of ventilation and perfusion, the last one being mediated by 1 - 25% by gravitational forces. Therefore, lung tissue density with vascularity is greatest at the dorsum in the supine position and at the bases in the upright position. Gravitational changes with posture also affect alveolar size at resting due to the impact of gravity on the regional transpulmonary pressure gradient, and there is a tendency towards increased distribution of ventilation towards the ventral region because of its higher freedom of movement compared to the dorsal chest wall. It is important to consider that the superimposed compression forces of the heart on the lungs, are of great influence, especially in the presence of a local or systemic inflammatory process [9].

Regarding mortality, we reported 67.8% of deaths, which represents 32.2% of patients discharged from the ICU due to improvement. A study conducted in China reported mortality in intubated patients with a mean number of days of ventilation of 4 days, before the popularization of the prone position [10].

In conclusion, our study identified that prone positioning achieved an improvement in the PO_2/FiO_2 ratio in patients with mechanical ventilation due to COVID-19. Given the heterogeneity of the published studies and the wide experience currently available in the management of acute COVID-19, studies showing the results obtained with the different modalities of pronation, as well as long-term follow-up in the evolution of these patients, are warranted.

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Conflict of interest: The authors declare that they have no conflict of interest.

References

1. Kharat, A., Simon, M., & Guérin, C. (2022). Prone position in COVID 19-associated acute respiratory failure. *Current opinion in critical care*, 28(1), 57.
2. McNicholas, B. A., Ehrmann, S., & Laffey, J. G. (2022). Awake prone positioning. *Intensive Care Medicine*, 48(12), 1793-1795.
3. Chua, E. X., Zahir, S. M. I. S. M., Ng, K. T., Teoh, W. Y., Hasan, M. S., Ruslan, S. R. B., & Abosamak, M. F. (2021). Effect of prone versus supine position in COVID-19 patients: A systematic review and meta-analysis. *Journal of Clinical Anesthesia*, 74, 110406.
4. Ziehr, D. R., Alladina, J., Petri, C. R., Maley, J. H., Moskowitz, A., Medoff, B. D., ... & Hardin, C. C. (2020). Respiratory pathophysiology of mechanically ventilated patients with COVID-19: a cohort study. *American journal of respiratory and critical care medicine*, 201(12), 1560-1564.
5. Johnson, S. A., Horton, D. J., Fuller, M. J., Yee, J., Aliyev, N., Boltax, J. P., ... & Lanspa, M. J. (2021). Patient-directed prone positioning in awake patients with COVID-19 requiring hospitalization (PAPR). *Annals of the American Thoracic Society*, 18(8), 1424-1426.
6. Jayakumar, D., Ramachandran, DNB, P., Rabindrarajan, DNB, E., Vijayaraghavan, MD, B. K. T., Ramakrishnan, AB, N., & Venkataraman, AB, R. (2021). Standard care versus awake prone position in adult nonintubated patients with acute hypoxemic respiratory failure secondary to COVID-19 infection—a multicenter feasibility randomized controlled trial. *Journal of Intensive Care Medicine*, 36(8), 918-924.
7. Stalla Alves da Fonseca, R., Martins Correa Boniatti, V., Carneiro Teixeira, M., Preisig Werlang, A., Martins, F., Henrique Rigotti Soares, P., ... & Luis Nedel, W. (2023). Mechanical Power in Prone Position Intubated Patients with COVID-19-Related ARDS: A Cohort Study. *Critical care research and practice*, 2023.
8. Okin, D., Huang, C. Y., Alba, G. A., Jesudasan, S. J., Dandawate, N. A., Gavralidis, A., ... & Lai, P. S. (2023). Prolonged prone position ventilation is associated with reduced mortality in intubated COVID-19 patients. *Chest*, 163(3), 533-542.
9. Kallet, R. H. (2015). A comprehensive review of prone position in ARDS. *Respiratory care*, 60(11), 1660-1687.
10. Wang, Y., Lu, X., Li, Y., Chen, H., Chen, T., Su, N., ... & Wang, J. (2020). Clinical course and outcomes of 344 intensive care patients with COVID-19. *American journal of respiratory and critical care medicine*, 201(11), 1430-1434.

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