JOURNAL OF INTERNATIONAL CRISIS AND RISK COMMUNICATION RESEARCH
ISSN: 2576-0017
2023, VOL 6, NO S8

Prone Position Versus Supine Position Effects On Intubated Patients With COVI-D19

Ahmed Hassan [1], Khalid Omar Hassan[2]

1. *Consultant intensive care medicine National Heart institute.*
2. *Senior specialist, Medical intensive care unit Rashid hospital, Dubai, UAE.*

ABSTRACT

Background: Prone positional treatment has demonstrated a reduction in mortality for severe hypoxia associated with Acute Respiratory Distress Syndrome (ARDS) by approximately fifty percent. These patients exhibit a response to positional therapy akin to that of other individuals with severe hypoxemic ARDS, despite the distinct characteristics of hypoxemic lung collapse induced by COVID-19 (Coronavirus Disease 2019, SARS-CoV-2).

Aim: This study aimed to compare outcomes between prone versus supine position in intubated patients with COVID-19.

Patients and methods: This study looked back at COVID-19 cases that occurred at Elsahel Hospital between 2021 and 2022. Because this was a retrospective study, we did not need patients' explicit consent. The study included 150 adults (≥ 18 years old) with ARDS who were admitted to the intensive care unit and underwent an intubation, as well as a confirmed SARS-CoV-2 infection as shown by positive results from real-time reverse transcriptase-polymerase chain reaction assays of nose and pharyngeal swabs. Upon admission to the intensive care unit, clinical data were gathered. Every day, data was collected regarding the prone position's application. Results were tracked by following up with patients.

Results: One hundred fifty COVID-19 patients were the subjects of this retrospective investigation. Out of the total number of patients treated in the intensive care unit, 111 (or 74% of the total) were turned prone at least once, whereas 39 (or 26% of the total) were treated while lying down. There were statistically significant differences ($p<0.05$) between the prone and supine positions, with the prone position exhibiting considerably greater neutrophil, LDH, and serum ferritin levels. The study found that patients in the prone position had lower lymphocyte and eosinophil counts compared to those in the supine position ($p<0.05$). Additionally, the prone position patients had higher respiratory rate, PaO2/FIO2 ratio, PaO2, and PEEP counts ($p<0.05$) than the supine position patients. Patients in a prone position had a significantly lower FiO2 and a longer duration of stay in the intensive care unit (ICU) compared to patients in a supine position, with statistical significance ($p<0.05$) for both variables.

Conclusion: During the COVID-19 pandemic, patients with respiratory failure receiving mechanical ventilation have often been treated in the prone position. When

in the prone position, the majority of patients' oxygenation rose, most likely due to better ventilation perfusion matching.

Key words: Prone position, COVID19, ARDS.

Introduction

The COVID-19 epidemic, which swept across 200 countries and claimed the lives of more than 3.9 million people, caused the World Health Organization to declare a public health emergency. There were 61,888 fatalities and 2.35 million COVID-19 instances in Indonesia as of July 2021. Intubation and mechanical ventilation were required in approximately 65 to 85 percent of critically ill COVID-19 patients admitted to the intensive care unit (ICU) due to hypoxemia and acute respiratory distress syndrome (ARDS). Respiratory failure with ARDS is known to have dismal results, and COVID-19 patients with ARDS are no different. Some nations, particularly those using mechanical ventilation, recorded a death rate of 61.5% [(1)].

Classic ARDS is not the same as pneumonia caused by the coronavirus disease 2019 (COVID-19) in a number of respects. Hyaline membrane alterations and micro-vessel thrombosis, which are uncommon in traditional ARDS, have been reported in autopsy reports of individuals who died with COVID-19 pneumonia. Additionally, COVID-19 pneumonia has a distinct anatomical position; the most prevalent CT symptoms are bilateral, peripheral, and multilobar ground-glass opacities, rather than implicating the dependent lung zones [(2,3)].

As a result, ground-grass opacities may not respond as well to prone stance in terms of reducing the mismatch between ventilation and perfusion. According to one research, there is no statistically significant difference in the respiratory system and lung mechanics when patients with COVID-19 pneumonia are ventilated while in a prone posture. According to this research, lung aeration is often maintained in COVID-19 pneumonia patients, and prone ventilation may potentially make the condition worse. This also implies that trans-pulmonary pressures may stay below dangerous limits and that lung mechanics during COVID-19 pneumonia may seem normal despite significant lung damage [(4,5)].

Evaluations of ARDS treatments conducted in the last several decades have shown that prone positioning, a non-pharmacological strategy, has the ability to save the lives of invasively ventilated patients with moderate to severe ARDS. Alveolar recruitment is more uniform across the lung and oxygenation efficiency is better with prone positioning because it promotes ventilation and minimizes intrapulmonary shunting [(6)].

Prone positioning during invasive mechanical ventilation enhanced oxygenation and reduced death rates in the intensive care unit, as indicated by a meta-analysis assessing prone posture in ARDS and acute lung injury. The World Health Organization and the Surviving Sepsis Campaign COVID-19 subcommittee advocate the prone position for the management of COVID-19-related acute respiratory distress syndrome. A recently emerged notion posits that COVID-19-related ARDS is distinct from non-COVID-19 ARDS, the latter being marked by severe hypoxemia and normal respiratory system compliance [(7,8)].

Given the pathophysiological distinctions between patients with conventional ARDS and those with COVID-19 pneumonia, it is natural to speculate that prone ventilation may not be as effective in COVID-19 patients. Thus, we conducted this retrospective study of the available data on the mortality outcomes for patients with COVID-19 that resulted from prone-position mechanical ventilation as opposed to supine-position mechanical ventilation.

Aim

This study aimed to compare outcomes between prone versus supine position in intubated patients with COVID-19.

Patients and Methods

Elsahel Hospital COVID-19 patients treated between 2021 and 2022 were the subjects of this retrospective study. No specific informed consent from patients was required due to the retrospective design of the study. In this study, 150 adults (≥ 18 years old) were included; all had to meet certain criteria, including being intubated, having a confirmed SARS-CoV-2 infection (i.e., positive results from real-time reverse transcriptase-polymerase chain reaction assay of nasal and pharyngeal swabs), and being admitted to the ICU for acute respiratory distress syndrome (ARDS), as defined by the Berlin criteria [9]. Patients under 18 years of age, those receiving solely non-invasive respiratory assistance, and individuals with incomplete clinical data concerning the use of prone positioning were excluded from the study.

Upon admission to the critical care unit, a thorough dataset was collected. This dataset included anthropometric and demographic information, comorbidities, and clinical data such as blood gas analysis, type of respiratory support, utilization of prone positioning, respiratory parameters, and laboratory testing. The length of stay in the intensive care unit, mortality rate, duration of mechanical ventilation, changes in the PaO2/FiO2 ratio, fluctuations in PaCO2, and the positioning of intubated COVID-19 patients with ARDS in prone versus supine were also monitored. Patients were deemed "O2-Responders" if, when lying flat on their backs, their PaO2/FiO2 ratio rose by at least 20 mmHg in comparison to their supine baseline values. Patients were also categorized as "CO2-Responders" in relation to carbon dioxide (CO2) clearance if, while in the prone position, their ventilatory ratio was lower than its baseline value while supine, meaning that there was a negative difference (ΔVR) between the two.

Data management:

All data were analyzed utilizing SPSS version 26.0. Characterization of quantitative variables by mean and standard deviation. Characterization of qualitative variables by frequency and percentage distributions. The independent t-test was employed to compare pairs of quantitative measurements with a normal distribution, whilst the Mann-Whitney U test was utilized as a non-parametric alternative. A P-value of less than 0.05 was deemed significant.

Results

One hundred fifty COVID-19 patients were the subjects of this retrospective investigation. Of these, 111 (or 74% of the total) were treated while prone in the intensive care unit, whereas 39 (or 26% of the total) were treated while supine (Figure 1).

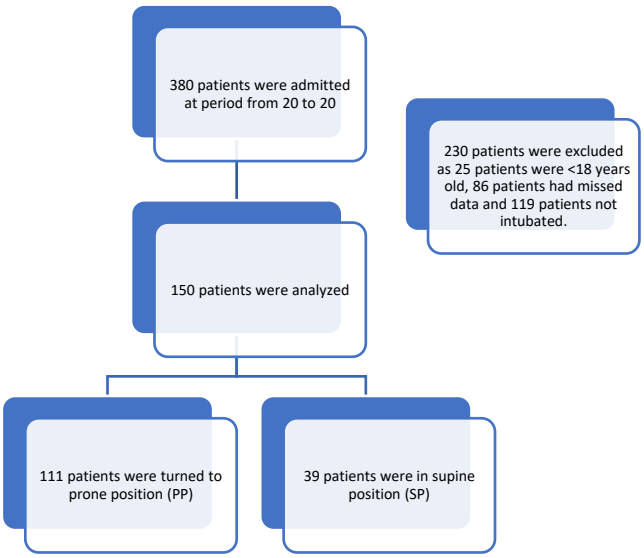

Figure 1: Flow chart of patients.

Table 1 compare the patients' demographic and clinical characteristics at ICU admission between both groups. Most patients were male in both group, age ranged from 45 to 79 years with statistical insignificant differences between groups. Patients in prone position were found to had significantly higher BMI, SOFA and APACH II score than patients in supine position with statistical significant differences as $p<0.05$.

Table 1: Basic demographic data of the study patients (n=150).

Variables	SP group (n = 39)	PP group (n = 111)	Test value	p value
Age (years)	62 (49–72)	59(45–79)	0.994	0.324
Gender no. (%) Males Females	 33(84.6) 6(15.4)	 79(71.7) 32(38.3)	1.21	0.083
BMI (kg/m2)	29(26–32)	30(27–33)	5.47	**0.001***
SOFA score	4 (3–4)	4 (3–5)	3.39	**< 0.001***
APACHE II score	9 (7–13)	10 (8–13)	2.183	**0.045***

Quantitative data were expressed as median [interquartile range] and qualitative data were expressed as frequency (percentage).

Abbreviations: BMI = Body Mass Index; SOFA = Sequential Organ Failure Assessment; APACHE II = Acute Physiologic Assessment and Chronic Health Evaluation II; FiO2 = Inspired fraction of oxygen.

Table (2) shows that patients in prone position were found to had significantly higher neutrophil, LDH and serum ferritin than patients in supine position with statistical significant differences as $p<0.05$. While patients in prone position were found to had significantly lower lymphocyte and eosinophil than patients in supine position with statistical significant differences as $p<0.05$.

Table 2: Laboratory data of the study patients (n=150).

Variables	SP group (n = 39)	PP group (n = 111)	Test value	p value
Hemoglobin (g\dl)	12.6±1.7	12.3±1.8	0.982	0.307[1]
Platelet ($\times10^9$ per L)	233.7±37.1	219.4±42.5	0.691	0.456[1]
Leucocyte ($\times10^9$ per L)	7.01±0.83	7.12±0.86	1.081	0.132[1]
Neutrophil ($\times10^9$ per L)	4.95±0.99	5.04±1.015	3.152	**0.001***
Lymphocyte ($\times10^9$ per L)	1.21±0.33	1.04±0.19	4.099	**<0.001***
Monocyte ($\times10^9$ per L)	0.53±0.11	0.52±0.12	0.051	0.947
Eosinophil ($\times10^9$ per L)	0.03±0.03	0.02±0.03	2.998	**0.007***
LDH (units/L)	478.13±66.27	538.35±90.51	4.411	**< 0.001***
D-dimer (ng/mL)	978.9±176.9	1476.8±236.8	6.176	**<0.001***
Ferritin (ng/mL)	1536.6±355.7	1682.8±428.02	**2.090**	**0.040***

LDH: lactate dehydrogenase

Table (3) shows that patients in prone position were found to had significantly higher respiratory rate, PaO_2/F_IO_2 ratio, PaO_2 and PEEP than patients in supine position with statistical significant differences as

p<0.05. While patients in prone position were found to had significantly lower FiO2 than patients in supine position with statistical significant differences as p<0.05.

Table 3: Respiratory data of the study patients (n=150).

Variables	SP group (n = 39)	PP group (n = 111)	Test value	p value
Respiratory Rate (breaths/min)	20(16–24)	21(20–25)	4.871	**< 0.001***
FiO_2 (%)	82(60–90)	62(50–78)	5.882	**< 0.001***
PEEP (cmH2O)	10(10–12)	12(10–14)	3.817	**< 0.001***
PaO_2/F_IO_2 ratio	110(85–150)	150(110–200)	7.817	**< 0.001***
Tidal volume/PBW (mL/kg)	7.0(6.4–8.0)	7.0(6.2–7.9)	0.314	0.764
pH	7.4(7.32–7.46)	7.39(7.32–7.45)	0.827	0.615
PaO_2 (mmHg)	75(70–95)	87(75–109)	6.725	**< 0.001***
$PaCO_2$ (mmHg)	45(36–50)	43(36–54)	0.615	0.552

FiO2 = Inspired fraction of oxygen; PEEP = Positive End-Expiratory Pressure; PBW: Predicted Body Weight; PaO2: partial pressure of oxygen in arterial blood; PaCO2: partial pressure of carbon dioxide in arterial blood•

Table (4) shows that patients in prone position were found to had significantly lower ICU mortality rate and longer ICU duration of stay than patients in supine position with statistical significant differences as p<0.05.

Table 4: Outcomes data of the study patients (n=150).

Variables	SP group (n = 39)	PP group (n = 111)	Test value	p value
ICU mortality, no. (%)	8(20.5)	7(6.3)	6.471	**0.025***
ICU LOS (days)	14(7–21)	18(11–30)	5.588	**< 0.001***

ICU: intensive care unit, LOS: length of Saty.

Discussion

This research showed that a greater PaO2/FiO2ratio was linked to COVID-19 individuals with ARDS in the prone position group as opposed to the supine position group. The results of this study are consistent with other research, indicating that prone posture may help damaged lungs oxygenate better [(10)].

A crucial part of diagnosing ARDS is the PaO2/FiO2 ratio. It is among the most important factors in the Berlin criteria. The ratio may be used to determine the severity of the condition, with 200–300 mmHg being considered light and 100–200 being PaO2/FiO2 values. As a result, it has become a useful tool for clinical treatment, prognosis, and diagnosis [(11)].

Prone positioning has been shown in several studies to increase the ventilation-perfusion ratio by expanding the compressed dorsal lung and reducing the pleural distribution of lung stress and strain [(6)].

The PROSEVA study found that severe ARDS patients placed in the prone position had a 28-day mortality rate of 16% and an unadjusted 90-day mortality rate of 23.6%, compared to those in the supine

position who had rates of 32.8% and 41%, separately [12]. Despite a considerable improvement in gas exchange and a decline in mortality, post hoc studies found no association between the two [12].

However, more recent research has refuted this finding. Park et al. discovered a correlation between clinical outcomes and the oxygenation improvement of COVID-19 ARDS after prone posture [12].

According to the findings, the main reason why oxygenation improves during the initial pronation of COVID-19 patients with ARDS is better ventilation-perfusion matching, which can be achieved by shifting flow from the dorsal to the ventral regions of the lungs [12].

An additional research by Camporota and colleagues also discovered that patients with COVID-19 ARDS had a strong oxygenation response, which was linked to a higher chance of survival [12].

Prone posture was suggested by many research to aid increase oxygenation and reduce respiratory effort. Furthermore, this evaluation looked at the PaCO2 levels in the two groups and discovered no significant correlation between the prone position and PaCO2 levels, which was in contrast to other research [13,14].

One of the main causes of aberrant gas exchange is a changed ventilation-perfusion ratio; a low ratio results in hypoxemia, while a high ratio causes hypercapnia. PaCO2 is the main regulator of air exchange under normal physiological conditions, particularly the minute ventilation or volume of air exchanged in the lung every minute. It is in charge of influencing the pH; if PaCO2 rises, the pH will fall and minute ventilation will rise. On the other hand, a drop in PaCO2 will raise pH and reduce minute ventilation [13].

A 2003 research by Gattinoni et al. revealed that ARDS patients' PaCO2 levels decreased in response to the prone posture [15].

According to our study, prone posture decreased physiological dead space and distended lung regions, which in turn decreased shunts and decreased PaCO2.

A meta-analysis gave potential explanation for why prone position did not substantially alter the PaCO2 level was that if prone position was used with pressure-controlled ventilation, the chest wall compliance would be decreased, which would lower the tidal volume and minute ventilation. In addition, a prone posture with volume-controlled breathing would result in higher pleural pressure, which would decrease venous return, impact regional perfusion, and increase dead space [16].

Mortality was reported in two articles: Weiss et al. [17] found that 55% of patients died in their research, whereas Langer et al. [18] found that 40.4% of patients died. Additionally, Langer et al. evaluated the death rates of patients in the prone and supine positions and found that 112/409 (28%) of the patients died in the supine position group. However, the author did not quantify the importance.

In agreement with our study results, Langer et al. [18] examined how long each group spent in the intensive care unit. Prone position patients' median duration of stay in the intensive care unit was substantially longer—16 days (IQR11–28)—than the median for the supine position group, which was 12 days (IQR7–21).

This finding corroborated prior research that suggested prone posture had a longer time to death and coincided with positive changes in physiological markers including the PaO2/FiO2 ratio. In addition, the prone position group's mechanical breathing time was significantly longer than the supine position group's [10,16]. The outcome may indicate that ARDS patients with more severe symptoms were treated with prone positioning as a salvage treatment.

There were several restrictions on our investigation. Potential flaws include selection bias and confounding factors restrict retrospective research, which can only conclusively establish connection rather than cause and effect.

Conclusion

The prone position has been often employed to treat patients with respiratory failure who are on mechanical ventilation during the COVID-19 epidemic. Most patients' oxygenation increased while they were in the prone position, most likely as a result of improved ventilation perfusion matching.

References

1. WHO Coronavirus Disease (COVID-19) Dashboard. Bangladesh Physiother J [Internet]. 2020;10(1).
2. Yang X, Yu Y, Xu J, Shu H, Xia J, Liu H, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. Lancet Respir Med [Internet]. 2020/02/24. 2020 May;8(5):475–81.
3. Organization WH. Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected. Interim guidance. Pediatr i Med Rodz [Internet]. 2020;16(1):9–26.
4. Astua AJ, Michaels EK, Michaels AJ. Proning During Pandemic: the rapid institution of a safe, transferable, and effective prone positioning program at Nychhc/elmhurst Hospital, a situationally resource limited facility, during the peak of the Covid 19 surge. 2020;
5. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020;395(10223):497–506.
6. Flynn Makic MB. Prone Position of Patients With COVID-19 and Acute Respiratory Distress Syndrome. J PeriAnesthesia Nurs [Internet]. 2020;35(4):437–8.
7. Caputo ND, Strayer RJ, Levitan R. Early Self-Proning in Awake, Non-intubated Patients in the Emergency Department: A Single ED's Experience During the COVID-19 Pandemic. Acad Emerg Med [Internet]. 2020 May;27(5):375–8.
8. Carsetti A, Damia Paciarini A, Marini B, Pantanetti S, Adrario E, Donati A. Prolonged prone position ventilation for SARS-CoV-2 patients is feasible and effective. Crit Care [Internet]. 2020 May 15;24(1):225.
9. Ranieri VM, Rubenfeld GD, Taylor Thompson B, Ferguson ND, Caldwell E, Fan E, et al. Acute respiratory distress syndrome: the Berlin Definition. JAMA J Am Med Assoc. 2012;307(23).
10. Shelhamer MC, Wesson PD, Solari IL, Jensen DL, Steele WA, Dimitrov VG, et al. Prone Positioning in Moderate to Severe Acute Respiratory Distress Syndrome Due to COVID-19: A Cohort Study and Analysis of Physiology. J Intensive Care Med [Internet]. 2021 Feb;36(2):241–52.
11. Ding L, Wang L, Ma W, He H. Efficacy and safety of early prone positioning combined with HFNC or NIV in moderate to severe ARDS: a multi-center prospective cohort study. Crit Care [Internet]. 2020 Jan 30;24(1):28.
12. Guérin C, Reignier J, Richard J-C, Beuret P, Gacouin A, Boulain T, et al. Prone positioning in severe acute respiratory distress syndrome. N Engl J Med. 2013;368(23):2159–68.
13. Malinoski DJ. Correlation of Central Venous and Arterial Blood Gas Measurements in Mechanically Ventilated Trauma Patients. Arch Surg [Internet]. 2005;140(11):1122.

14. Byrne AL, Bennett M, Chatterji R, Symons R, Pace NL, Thomas PS. Peripheral venous and arterial blood gas analysis in adults: are they comparable? A systematic review and meta-analysis. Respirology [Internet]. 2014;19(2):168–75.

15. Gattinoni L, Chiumello D, Caironi P, Busana M, Romitti F, Brazzi L, et al. COVID-19 pneumonia: different respiratory treatments for different phenotypes? Intensive Care Med [Internet]. 2020/04/14. 2020 Jun;46(6):1099–102.

16. Park J, Lee HY, Lee J, Lee S-M. Effect of prone positioning on oxygenation and static respiratory system compliance in COVID-19 ARDS vs. non-COVID ARDS. Respir Res. 2021;22:1–12.

17. Weiss TT, Cerda F, Scott JB, Kaur R, Sungurlu S, Mirza SH, et al. Prone positioning for patients intubated for severe acute respiratory distress syndrome (ARDS) secondary to COVID-19: a retrospective observational cohort study. Br J Anaesth. 2021;126(1):48–55.

18. Langer T, Brioni M, Guzzardella A, Carlesso E, Cabrini L, Castelli G, et al. Prone position in intubated, mechanically ventilated patients with COVID-19: a multi-centric study of more than 1000 patients. Crit Care. 2021;25:1–11.