A Descriptive Study on Effectiveness of Prone Position on Prognosis of COVID-19 Patients in Selected Hospital

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Abstract: ***Background**: Limited data are available on the use of prone position in intubated, invasively ventilated patients with Coronavirus disease-19 (COVID-19). Aim of this study is to investigate the use and effect of prone position in this population during the first 2020 pandemic wave. **Methods**: Retrospective, multicentre, national cohort study conducted [Dec 2021, Jan 2022 & Feb 2022] in Multidisplinary Critical Care Units (MDCCU) on adult patients needing invasive mechanical ventilation for respiratory failure caused by COVID-19. Clinical data were collected from the patient file. Information regarding the use of prone position was collected daily. The respiratory effects of the first prone position were studied in a subset of 60 patients. Patients were classified as Oxygen Responders if the PaO_2/FiO_2 ratio increased ≥ 20 mmHg during prone position and as Carbon Dioxide Responders if the ventilator ratio was reduced during prone position. **Results**: Out of 60 patients majority of the patients were aged between 30-40 years (38.4%), Hindus 46.6%, married 56.6%, secondary education 36.6%. With regard to other variables, 30% were diabetic, 28.4% of them were private employees, 51.6% of them had 3 or more children, 40% of them were admitted through ER, 43.4% of them stayed 20-30 days. Association between selected demographic variables and effectiveness of the prone position to increase the oxygenation of the patient with SARS-cov-2 pneumonia as a lung recruitment index was significant. the number of days the patient was on ventilator, that, majority of the patients were on ventilator >30 days 31.7%, on AC/PC mode 51.7%, plateau pressure before prone 40%, driving pressure before prone 38.4%. Plateau pressure after 24hrs of prone and driving pressure after 24hrs of prone nursing was 38.3%. The mean overall score of effectiveness was 13.2/57.39 with SD 2.93 with range of 7-20. There was statistical significant association between selected background variables and duration of stay ($p<0.05$). However there was no statistically significant association between background variables and age, patient prognosis ($p>0.05$). There was statistically significant association between selected background variables and duration of stay ($p<0.05$). However there was statistically significant association between background variables and age, patient prognosis ($p<0.05$). **Conclusions**: During the COVID-19 pandemic, prone position has been widely adopted to treat mechanically ventilated patients with respiratory failure. The majority of patients improved their oxygenation during prone position, most likely due to a better ventilation perfusion matching.*

Keywords: Prone position in COVID-19, Acute respiratory distress syndrome, Mechanical ventilation, Pathophysiology, Plateau pressure, driving pressure, Nursing management of COVID-19

1. Introduction

Prone positioning is known to improve the PaO2/FiO2 ratio and reduce mortality in patients with ARDS managed in the critical care setting. Therefore, it is incorporated into regular clinical practice of managing patients with ARDS in critical care and is being used as such in the COVID-19 outbreak. Given that prone positioning is recommended by the Intensive Care Society in non-ventilated patients with COVID-19, there is an urgent need to better understand the physiological effects of prone positioning in such cases. Furthermore, the translation and applicability of such a low-cost non-invasive intervention in a wider group of patients with pneumonia not specific to COVID-19 infection, is an important consideration that merits investigation.

Late 2019, a new virus was introduced to the world, which caused COVID-19. The virus rapidly spread all over the world and led to a high rate of mortality and became a great challenge for the healthcare staff. SARS-CoV-2 virus causes a pneumonia that was identified through fever, dyspnea, and acute respiratory symptoms and named COVID-19. This disease exacerbates in a number of patients and causes multi-organ failure, and acute respiratory distress syndrome (ARDS). Prevalence of ARDS category among COVID-19 patients has been reported to be up to 17%.

ARDS was first introduced in 1968 with clinical presentations of acute severe hypoxemia, non-cardiac pulmonary edema, decrease in pulmonary compliance, and increase in work of breathing. It was especially seen in patients who had an underlying sepsis, pneumonia, and aspiration or severe trauma and all of these patients were in need of positive pressure ventilation 10% of patients who are admitted to the intensive care unit (ICU) develop ARDS and despite all the treatment advances made, the rate of mortality is still high among these patients and has been reported to be between 30% and 40%.

Among the treatment options for management of ARDS patients, prone position can be used as an adjuvant therapy for improving oxygenation in these patients. It should be prescribed along with low tidal volume (6 cc per kg body weight) and high PEEP as per ARDS net protocol infusion of neuromuscular blockers. These 3 treatment strategies together, lead to improvement in oxygenation and survival of ARDS patients.

The main mechanisms of prone position in improvement of ARDS patients' condition are affecting recruitment in dorsal lung regions, increasing end-expiratory lung volume, increasing chest wall elastane, decreasing alveolar shunt, and improving tidal volume. However, correct selection of patients and applying the proper treatment protocol for prone positioning are key to its effectiveness. For instance, in a meta-analysis, Munshi et al. expressed that prone position can lead to a drop in the rate of mortality among patients with severe ARDS when applied to patients for least 12 hours a day.

Richard, J. C et al (2013) conducted a study on previous trials involving patients with the acute respiratory distress syndrome (ARDS) have failed to show a beneficial effect of prone positioning during mechanical ventilator support on outcomes. We evaluated the effect of early application of prone positioning on outcomes in patients with severe ARDS. A total of 237 patients were assigned to the prone group, and 229 patients were assigned to the supine group. The 28-day mortality was 16.0% in the prone group and 32.8% in the supine group (P<0.001). The hazard ratio for death with prone positioning was 0.39 (95% confidence interval [CI], 0.25 to 0.63). Unadjusted 90-day mortality was 23.6% in the prone group versus 41.0% in the supine group (P<0.001), with a hazard ratio of 0.44 (95% CI, 0.29 to 0.67). The incidence of complications did not differ significantly between the groups, except for the incidence of cardiac arrests, which was higher in the supine group.

A study was conducted to improve gas exchange in ARDS by Scholten, E. L et al (2017) Subsequent observations of dramatic improvement in oxygenation with simple patient rotation motivated the next several decades of research. This work elucidated the physiological mechanisms underlying changes in gas exchange and respiratory mechanics with prone ventilation. However, translating physiological improvements into a clinical benefit has proved challenging; several contemporary trials showed no major clinical benefits with prone positioning. By optimizing patient selection and treatment protocols, the recent Proning Severe ARDS Patients (PROSEVA) trial demonstrated a significant mortality benefit with prone ventilation. This trial, and subsequent meta-analyses, support the role of prone positioning as an effective therapy to reduce mortality in severe ARDS, particularly when applied early with other lung-protective strategies. This review discusses the physiological principles, clinical evidence, and practical application of prone ventilation in ARDS.

A Retrospective single-center study was conducted in Community academic medical ICU by Douglas, I. S et al (2021) for Sequential mechanically ventilated patients with coronavirus disease 2019 acute respiratory distress syndrome. Prone position ventilation is a potentially life-saving ancillary intervention but is not widely adopted for coronavirus disease 2019 or acute respiratory distress syndrome from other causes. Implementation of lung-protective ventilation including prone positioning for coronavirus disease 2019 acute respiratory distress syndrome is limited by isolation precautions and personal protective equipment scarcity. We sought to determine the safety and associated clinical outcomes for coronavirus disease 2019 acute respiratory distress syndrome treated with prolonged prone position ventilation without daily repositioning. Lung-protective ventilation and prolonged protocolized prone position ventilation without daily supine repositioning. Supine repositioning was performed only when FIO_2 less than 60% with positive end-expiratory pressure less than 10 cm H_2O for greater than or equal to 4 hours. Prolonged prone position ventilation was feasible and relatively safe with implications for wider adoption in treating critically ill coronavirus disease 2019 patients and acute respiratory distress syndrome of other etiologies.

Mathews, K. S et al (2021) conducted a study to estimate the effect of early proning initiation on survival in patients with coronavirus disease 2019–associated respiratory failure. Target trial of prone positioning ventilation by categorizing mechanically ventilated hypoxemic (ratio of Pao_2 over the corresponding $Fio_2 \leq 200$ mm Hg) patients as having been initiated on proning or not within 2 days of ICU admission. We fit an inverse probability–weighted Cox model to estimate the mortality hazard ratio for early proning versus no early proning. Among 2, 338 eligible patients, 702 (30.0%) were proned within the first 2 days of ICU admission. A total of 1, 017 (43.5%) of the 2, 338 patients were discharged alive, 1, 101 (47.1%) died, and 220 (9.4%) were still hospitalized at last follow-up. Patients proned within the first 2 days of ICU admission had a lower adjusted risk of death compared with nonproned patients (hazard ratio, 0.84; 95% CI, 0.73–0.97). In-hospital mortality was lower in mechanically ventilated hypoxemic patients with coronavirus disease 2019 treated with early proning compared with patients whose treatment did not include early proning.

A study was conducted to determine the prevalence of use of PP in ARDS patients (primary endpoint) by Guerin, C et al (2018) the physiological effects of PP, and the reasons for not using it (secondary endpoints). On each study day, investigators in each ICU had to screen every patient. For patients with ARDS, use of PP, gas exchange, ventilator settings and plateau pressure (Pplat) were recorded before and at the end of the PP session. Complications of PP and reasons for not using PP were also documented. Values are presented as median (1st–3rd quartiles). Over the study period, 6723 patients were screened in 141 ICUs from 20 countries (77% of the ICUs were European), of whom 735 had ARDS and were analysed. In conclusion, this prospective international prevalence study found that PP was used in 32.9% of patients with severe ARDS, and was associated with low complication rates, significant increase in oxygenation and a significant decrease in driving pressure.

2. Material and Methods

The research design spells out the basic strategies that the researcher adopts to develop information that is accurate and interpretable. A retrospective descriptive research design was adopted for this study. It is a Retrospective Descriptive Research Design conducted in Apollo Speciality Hospitals, Vanagaram for 3 months [Dec 2021, Jan 2022 & Feb 2022], the sample size was 60 patients. The Paired test based on inclusion criteria, the subject & selection criteria was Convenient sampling who fulfilled inclusion criteria

Inclusion criteria:

This study includes the patients with COVID-19 who are

- Category C on Room Air with Spo2<90% with O2 5L/min (40%-fio2) / HFNC/NIV/Mechanical Ventilator
- Willing for proning based on consent from the attendant
- Driving pressure above 18 & plateau pressure more than 13.

Exclusion criteria:

Patients with COVID-19 who are

- Not on ventilator

Procedure Methodology:

Data was collected after obtaining ethical clearance from Apollo Specialty Hospital, Vanagram. Data was collected through validated tools such as demographic variables proforma such as age, religion, marital status, education, occupation, number of children, mode of admission, duration of stay, patient prognosis and clinical variables proforma of COVID-19 from patient files such as total ventilator days, mode of ventilator support, plateau pressure before prone, driving pressure, plateau pressure and driving pressure after 24hrs of prone positioning.

The usual settings for protective ventilation during one lung ventilation are tidal volume (V_T) 5 to 6 ml/kg of predicted body weight (PBW), positive end-expiratory pressure (PEEP) to 5 cmH_2O and plateau pressure (Pplat) to less than 25 cmH_2O [9–13]. Driving pressure is the plateau airway pressure minus PEEP. Normal driving pressure is 12 to 18. It can also be expressed as the ratio of tidal volume to respiratory system compliance, indicating the decreased functional size of the lung observed in patients with ARDS. Plateau pressure is the pressure that is applied by the mechanical ventilator to the small airways and alveoli. Normal plateau pressure is 9 to 13. The doctors will decide seeing the Plateau pressure and the driving pressure, to put the patient in prone position.

3. Result & Discussion

This study was conducted to assess the effectiveness of prone position on prognosis of COVID-19 patients.

Table 1, Fig 1& 2 Majority of the patients were aged between 30-40 years (38.4%), Hindus 46.6%, married 56.6%, secondary education 36.6%. With regard to other variables, 30% were diabetic, 28.4% of them were private employees, 51.6% of them had 3 or more children, 40% of them were admitted through ER, 43.4% of them stayed 20-30 days. Association between selected demographic variables and effectiveness of prone position to increase the oxygenation of the patient with SARS-cov-2 pneumonia as a lung recruitment index was not significant.

Table 2 & Fig 3 depicts the number of days the patient was on ventilator, that, majority of the patients were on ventilator >30 days 31.7%, on AC/PC mode 51.7%, plateau pressure before prone 40%, driving pressure before prone 38.4%. Plateau pressure after 24hrs of prone and driving pressure after 24hrs of prone nursing was 38.3%.

Table 3 depicts that the mean overall score of effectiveness was 13.2/57.39 with SD 2.93 with range of 7-20.

Table 4 depicts that there was statistical significant association between selected background variables and duration of stay (p<0.05). However, there was statistical significant association between background variables and age, patient prognosis (p<0.05).

Table 1 & Fig 1 & 2: Frequency and Percentage distribution of demographic variables among patients with COVID-19, (N=6**0)**

Variables	F	%
Age in Years		
30-40 years	23	38.4
41-50 years	12	20
51-70 years	16	26.6
70 & Above	9	15
Religion		
Hindu	28	46.6
Christian	17	28.4
Muslim	15	25
Others	0	0
Marital Status		
Married	34	56.6
Single	17	28.4
Divorced	6	10
Widowed	3	5
Education		
No formal Education	8	13.4
Primary	17	28.4
Secondary	22	36.6
Illiterate	13	21.6
Co-morbidities		
Diabetic	18	30
Hypertension	15	25
COPD	12	20
CKD	11	18.3
Others	4	6.6
Occupation		
Government	16	26.6
Private	17	28.4
Business	13	21.6
Home maker	14	23.4
Number of Children		
No Children	6	10
1 or 2	23	38.4
3 or more	31	51.6
Mode of admission		
From ER	24	40
From OPD	14	23.4
Direct admission	13	21.6
Transferred from other hospital	9	15
Duration of stay		
5-10 days	3	0.5
10-20 days	18	30
20-30 days	26	43.4
More than a month	13	21.6
Patient prognosis		
Discharged	27	45
Transferred to ward	13	21.6
Expired	11	18.4
DAMA	9	15

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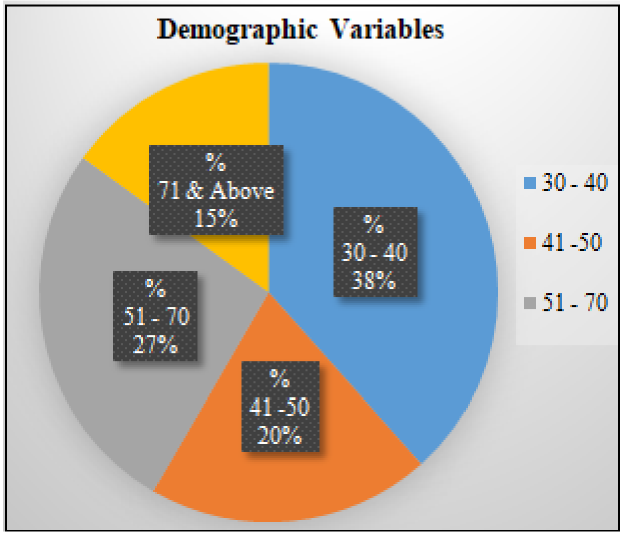

Figure 1: Percentage Distribution of COVID-19 Patient Demographic Variables

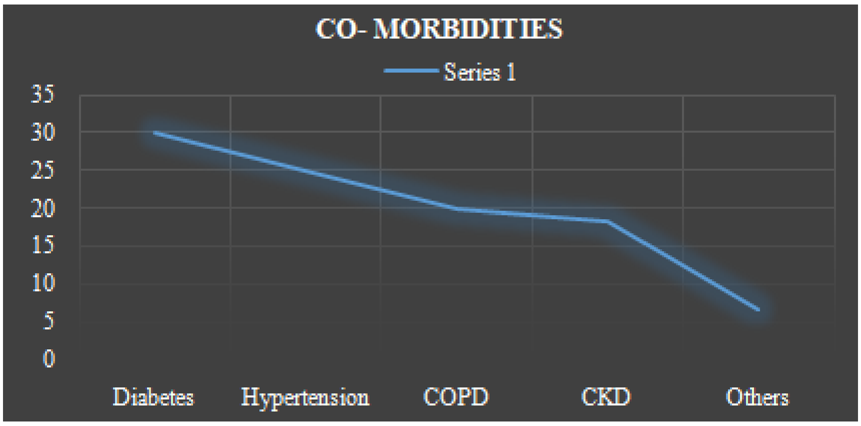

Figure 2: Percentage Distribution of Co-Morbidities

Table 2: Frequency and Percentage Distribution of Modified COVID-19 Prone Position (CPP)

Variables	F	%
Number of days the patient on ventilator after prone position		
Less than 5 days	11	18.3
5-10 days	13	21.7
10-30 days	17	28.3
> 30 days	19	31.7
What mode of Ventilator Support?		
SIMV	6	10
AC/VC	18	30
BILEVEL	5	8.3
AC/PC	31	51.7
Plateau Pressure before prone		
> 30	4	6.7
> 40	11	18.3
< 30	24	40
> 50	21	35
Driving Pressure before prone		
< 50	23	38.4
> 50	14	23.3
< 30	17	28.3
> 15	6	10
Plateau Pressure after 24hrs of prone		
Day-1	9	15
Day-2	9	15
Day-3	9	15
Day-4	9	15
Day-5	10	16.6
Day-6	11	18.3
Day-7	11	18.3

Driving Pressure after 24hrs of prone	22	36.7
Day-1	23	38.3
Day-2	5	8.4
Day-3	2	3.3
Day-4	3	5
Day-5	2	3.3
Day-6	3	5
Day-7	22	36.7

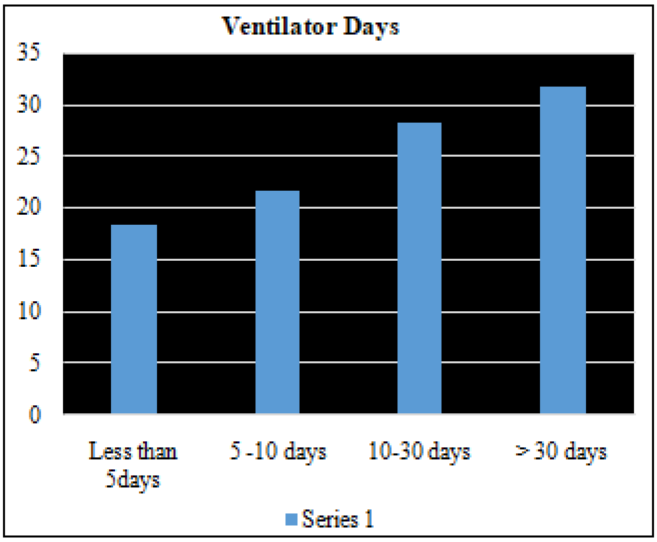

Figure 3: Ventilator days

Table 3: Mean and Standard Deviation shows effectiveness of prone position to increase the oxygenation of the patient with SARS-cov-2 pneumonia as a lung recruitment index, (N=60)

Variables	Obtainable Score	Max & Min Score (Obtained score)		Mean	Mean%	SD
		Max	**Min**			
Effectiveness	0-23	20	7	13.2	57.39	2.93

Table 4: Association between selected Demographic Variables and effectiveness of prone position to increase the oxygenation of the patient with SARS-cov-2 pneumonia as a lung recruitment index

Variables	n	Effectiveness Scores		χ2	p value
		Upto Mean Score	Above Mean Score		
Age					
30-50years	35	19	16	1.19 NS	p>0.05
60-80years	25	10	15		
Duration of Stay					
5-20 days	21	6	15	5.05 S	p<0.05
Within a month	39	23	16		
Patient Prognosis					
Discharged and transferred to ward	40	23	16	5.05 S	P<0.05
Expired and DAMA	20	5	15		

There was a no statistical significant association between background variables and age (p>0.05). There was statistically significant association between selected background variables and duration of stay (p<0.05). However, there was a statistical significant association between the background variables and patient prognosis (p<0.05).

Similar findings were found in the study conducted by Guerin, C et al (2018) to determine the prevalence of use of PP in ARDS patients (primary endpoint) the physiological effects of PP, and the reasons for not using it (secondary endpoints). On each study day, investigators in each ICU had to screen every patient. For patients with ARDS, use of PP, gas exchange, ventilator settings and plateau pressure (Pplat) were recorded before and at the end of the PP session. In conclusion, this prospective international prevalence study found that PP was used in 32.9% of patients with severe ARDS, and was associated with low complication rates, significant increase in oxygenation and a significant decrease in driving pressure.

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4. Conclusion

The study findings revealed that the prone position was effective in improving the oxygenation of the patient with SARS-cov-2 pneumonia as a lung recruitment index. Prone position is powerful intervention tool that can be incorporated in COVID-19 patients to improve the oxygenation.

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