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Effects of the prone position in the treatment of acute respiratory syndrome in patients with COVID-19

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Abstract
Objective: To measure the effects of the prone position on ventilatory parame-ters in the treatment of patients with acute respiratory syndrome secondary to COVID-19. Methods: Through a descrip-tive, cross-sectional, prospective study, a sample of 103 patients with acute respira-tory syndrome (ARDS) secondary to COVID-19 was studied. The patients were placed in the prone position indefinitely and clinical ventilatory parameters were monitored such as blood pressure oxygen (PaO2), oxygen saturation (SatO2) and relationship between partial pressure of oxygen and inspired fraction of oxygen (PaO2 / FiO2). Results: The concentration of FiO2 decreased from 100% in the su-pine position to 69% in the prone position, the PaO2 / FiO2 increased from 74 to 122 millimeters of mercury (mmHg), the basal PaO2 was recorded at 51 mmHg and after the change in position it was of 89 mmHg, also the SatO2 improved from 84% to 93%. Conclusions: The prone position can significantly improve the PaO2, SatO2 values, as well as the PaO2 / FiO2 ratio, and in general, the clinical status of the patient with ARDS.
Key-words: Prone position. Acute respirato-ry syndrome. COVID-19. Mechanical ventilation.

Introduction

Coronaviruses are an extended family ribonucleic acid virus (RNA) that cause disease in both animals as well as humans. In humans, several coronaviruses are known cause respiratory infections that can range from the common cold to more serious illnesses such as the syndrome acute respiratory distress (ARDS). The coronavirus that has been discovered most recently in December 2019, released as SARS-CoV-2 causes the disease called better known 'coronavirus disease 19' like COVID-19.[1,2]

Currently COVID-19 is a pandemic affecting countries around the world. Its most common symptoms are fever, dry cough, and tiredness. Other symptoms less frequent affecting some patients are aches and pains, nasal congestion, pain from head, conjunctivitis, sore throat, diarrhea, loss of taste or smell and skin rashes or changes color on the fingers or the feet. These symptoms are usually mild and they start gradually.[3]

About 1 in 5 people who contract COVID-19 have a severe condition and experience difficulties to breathe. Older people and who have previous medical conditions such as high blood pressure, problems heart or lung, diabetes or cancer are more likely to have grave symptoms. However, any person can get COVID-19 and fall seriously ill.[4] It is estimated that between 5 and 12% of cases, suffer from a distress syndrome very severe acute respiratory tract (ARDS) from severe pneumonia, which can lead to a multiple organ failure with a lethality elevated.[5]

ARDS consists of an insufficiency respiratory secondary to edema inflammatory lung, with increased capillary permeability and consequent passage of fluids to the pulmonary interstitium and then to the alveolar spaces. Clinically COVID-19 is present with severe hypoxemia, bilateral pulmonary infiltrates in chest X-ray, and great fall of the lung compliance or compliance, which is expressed as a requirement of high insufflation pressures during mechanic ventilation.[6]

In severe ARDS, the dorsal alveoli are more affected; require very high pressures for opening or recruitment. Additionally, the pulmonary circulation is preferentially distributed in the dorsal regions, which contributes to the generation of extensive shunt areas. In these conditions, the applied tidal volume will be directed to the regions that offer the least resistance, that they will be more exposed to suffering from overdistention (this is known as ventilation-induced injury during the end of inspiration).[7]

At present, in the treatment of ARDS ventilation is recommended mechanics with low tidal volumes and positive pressure at the end of expiration (PEEP). However, there are

patients who hypoxemic persists and forces us to propose the use of alternatives therapies aimed at improving oxygenation arterial, treatment with prone position (PD) is a of them.[8]

The first studies about the management of ventilated patients on PD emerged in the early 70s; in they alluded to the improvement in oxygenation as a result of this maneuver. In 1974 Bryan first alerted once about the potential benefits of PD in the ventilated patient.8 The resurgence PD therapy is due to the reports of some pioneers in their employment, like Gattinoni and Lachmann in Europe.[9]

PD studies confirm the hypothesis in which the distribution of the perfusion presents a nongravitational gradient. As the zones are not dependent the best perfused, and by increasing the volume of aerated lung in PD, produces a marked improvement in the relationship ventilation / perfusion.[10,11]

Others influencing factors for this type of perfusion distribution are the architecture fractal of the vessels, the largest nitric oxide production in areas dorsal with respect to the ventral and less vascular resistance in areas dorsal.[12]

Fernández, Catarinella and Chacón, demonstrated that the implementation early prolonged sessions of pronation is associated with a decrease of mortality in patients with ARDS through various physiological mechanisms. The combination of pronation with non-invasive breathing supports in the ARDS can lead to better effects physiological effects on the imbalance in ventilation / perfusion ratio, a better drainage of purulent secretions into the ARDS of infectious cause and a greater homogeneity in the mechanics of ARDS while the patient is supported with positive pressure.[13]

Cabrera, Carrera and Méndez, evaluated gas exchange and behavior hemodynamic in patients with ARDS before, during and after the change from supine position to prone position. Five patients with ARDS and severe exchange disturbances gaseous were included in the study. Exchange variables gas were evaluated upon admission in decubitus supine, after one hour of decubitus prone, twelve hours of decubitus prone and two hours after return to supine position. After an hour in prone position, all patients presented an increase in arterial oxygen pressure (PaO2), ratio arterial oxygen pressure and fraction inspired oxygen (PaO2 / FIO2) and in arterial oxygen saturation (SatO2).[14]

The present study was aimed at evaluate the effects of decubitus prone on ventilatory clinical parameters in patients with syndrome acute respiratory distress as a consequence of COVID-19.

Methodology

A descriptive, cross-sectional, prospective study was designed. The population was conformed by patients with syndrome of acute respiratory distress treated in a second level care hospital from the State of Nuevo León, Mexico, which was converted for treatment COVID-19 patients during the period from 01-05-2020 to 31-08-2020.

A not probabilistic sample was collected for consecutive cases. It was excluded patients with diagnosis different from acute respiratory syndrome, as well as those in shock. It was eliminated those participants who did not completed a minimum of 16 hours in prone position.

The patients were identified with suspected ARDS through a respiratory triage, in the emergency area, where all those who require hospitalization, they were invitation to participate in the study, obtaining informed consent, in addition to taking the reaction test polymerase chain (PCR) for SARS-CoV-2 as a diagnosis for COVID-19 by throat swab and nasopharyngeal.

The clinical history of the patient and if he reported symptoms of ARDS, they proceeded to measure their initial ventilatory parameters as percent saturation of oxygen (SatO2), by oximeter pulse; arterial gases, by certified gasometer; blood pressure ratio of oxygen and inspired fraction of oxygen (PaO2 / FiO2), by means of Kirby index formula, taking as a base a fraction inspired oxygen (FiO2) of 21%.Subsequently, we proceeded to place in the prone position and monitored the same parameters ventilatory. If the participant required mechanical ventilation, in the same way we proceeded to put it on and stay in DP, preventing at all times adverse effects such as ulcers by pressure. Ventilatory parameters were measured immediately after pronation, to 60 minutes after and after every two hours until complete a minimum of 16 hours, after which he returned to supine position. After the supination, we were monitoring the ventilatory parameters every 2 hours for 12 hours continuous. In the case of patients with mechanical ventilation, the values were also motorized of positive pressure at the end of expiration (PEEP). The state of gravity was assessed at the time of admission through the APACHE scale (Acute Physiology And Chronic Health Evaluation) II of 12 factors: body temperature, pressure mean arterial (MAP), frequency heart rate, respiratory rate oxygenation, arterial pH, plasma sodium (Na), plasmatic potassium (K), creatinine hematocrit, white blood cell count and Glasgow coma scale (GCS). As additional data, the type and blood Rh of the participants. The information was captured in a database electronic data, for later analysis with the help of software statistical calculation. The data were analyzed with descriptive statistics to characterize the population study through measurements central tendency analysis of frequencies and percentages. Subsequently an inferential analysis was done with each of the variables of interest, searching association of the same through correlation coefficient and posterior regression test, as well as mean comparison tests between those variables that make up analysis groups (test t for two groups, ANOVA test for three or more analysis groups). The normality of the sample was tested with Kolmogorov Smirnov test. Nursing standardized cares were applied in order to prevent ulcers by pressure, controlling the pressure points, rotating patients' position every two hours, and placing them in a swimmer position. The ethical principles for scientific research in human rights were respected; likewise, the principles established in the Declaration from Helsinki were complied.

Results

A total of 103 patients were treated who met the criteria inclusion for the study. Of the total participants, 56% was male and 44% of female sex. The average age of the subjects was 53 ± 13 years old. A 91% of patients with ARDS, tested positive for SARS-CoV-2, while the remaining 9% were negative to diagnostic test of PCR. Comorbidity more frequent was diabetes mellitus (65 %), followed by arterial hypertension (54%), obesity (33%) and asthma (17%). With respect to blood types, the distribution was as follows: blood type A,

44%, type B, 24%, type O, 20%, type AB, 12%.Likewise, 79.6% of the participants required mechanical ventilation during your treatment with an average of 6 days continuous with fan. The average of days of hospitalization was 11 days.

The effect of the prone position caused improvement over PaO2, SatO2, and PaO2 / FiO2 from the first hour of change of position from supine to prone, so it can be considered that during the first hour of decubitus position prone, 100% of the patients presented adequate response (see table 1).

Table 1. Effects of one hour in the prone position on clinical ventilatory parameters

		ẋ		
Position	PaO_2	$PaCO_2$	$SatO_2$	PaO_2/FiO_2
Basal Supine	51 mmHg	45 mmHg	84%	74 mmHg
Prone	89 mmHg	37 mmHg	93%	122 mmHg

PaO2, arterial oxygen pressure; PaCo2, blood pressure of carbon dioxide; SatO2, oxygen saturation; FiO2, inspired fraction of oxygen; mmHg, millimeters of mercury.

The baseline average of the parameters ventilator related to exchange gaseous, was also improved after first hour of placement in decubitus prone, showing statistical significance in most of them. Concentration of FiO2 contributed decreased from 100 % in supine position to 69% in decubitus prone, PaO2 / FiO2 increased from 74 at 122 millimeters of mercury (mmHg), baseline PaO2 was recorded at 51 mmHg and after the change of position was 89 mmHg, also the SatO2 improved from 84% to 93% (see table 2).

Table 2. Variables related to gas exchange and oxygen transport in the supine basal position and after one hour in the prone position

		ẋ	
Variable	Basal position (supine)	Prone position (1 hour)	P value
FiO_2 %	100	69	<0.05
PaO_2/FiO_2	74 mmHg	122 mmHg	<0.05
pH	7.3	7.35	>0.05 (NS)
$PaCO_2$	45 mmHg	37 mmHg	>0.05 (NS)
PaO_2	51 mmHg	89 mmHg	<0.05
$SatO_2$	84%	93%	<0.05

FiO2, inspired fraction of oxygen; PaCO2, blood pressure of carbon dioxide; PaO2, arterial oxygen pressure; SatO2, arterial oxygen saturation; mmHg, millimeters of mercury; NS, not significant.

Twelve hours after the change of position profits became more obvious. Concentration decreased FiO2 at non-toxic values, the PaO2 / FiO2 remained at 130 mmHg and positive pressure at the end of expiration which needed values up to 15 cmH2O in the entire group of patients with mechanical ventilation, decreased to average of 10 cmH2O (see table 3).

Table 3. Variables related to gas exchange and oxygen transport in the supine basal position and after twelve hours in the prone position

		ẋ	
Variable	Basal position (supine)	Prone position (12 hours)	P value
FiO_2 %	100	60	<0.05
PaO_2/FiO_2	74 mmHg	130 mmHg	<0.05
pH	7.3	7.39	>0.05 (NS)
$PaCO_2$	36 mmHg	35 mmHg	>0.05 (NS)
PaO_2	51 mmHg	84 mmHg	<0.05
$SatO_2$	84%	94%	<0.05
PEEP	15 cmH_2O	10 cmH_2O	>0.05 (NS)

FiO2, inspired fraction of oxygen; PaCO2, blood pressure of carbon dioxide; PaO2, arterial oxygen pressure; SatO2, arterial oxygen saturation; PEEP, positive pressure at the end of expiration; NS, not significant.

Upon completing 16 hours in position prone position the patients were returned supine, being able maintain ventilatory parameters obtained in a prone position. After 12 hours of having been returned to decubitus supine (after 16 continuous hours of decubitus prone) the beneficial effects on the ventilatory parameters obtained in prone position, were permanent (see table 4).

Table 4. Variables related to gas exchange and oxygen transport in the supine basal position and in the supine position after 16 hours in the prone position

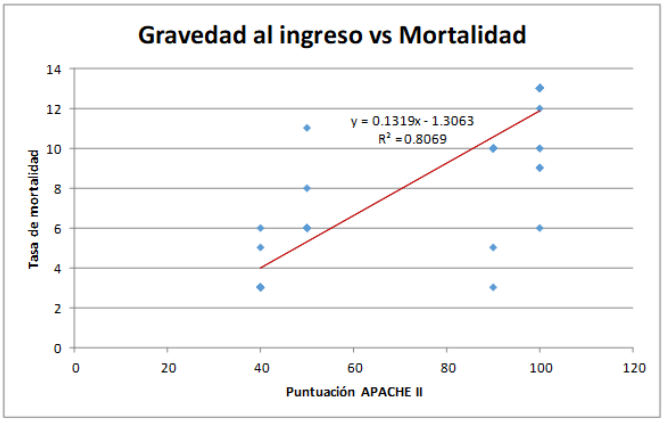
		ẋ	
Variable	Basal position (supine)	Supine position 12 hours after being in the prone position for 16 continuous hours	P value
FiO_2 %	100	60	<0.05
PaO_2/FiO_2	74 mmHg	160 mmHg	<0.05
pH	7.3	7.41	>0.05 (NS)
$PaCO_2$	36 mmHg	33 mmHg	>0.05 (NS)
PaO_2	51 mmHg	97 mmHg	<0.05
$SatO_2$	86%	96%	<0.05

FiO2, inspired fraction of oxygen; PaCO2, blood pressure of carbon dioxide; PaO2, arterial oxygen pressure; SatO2, arterial oxygen saturation; NS, not significant.

The comparative analysis of means by groups, showed that the subjects of the group blood A, were more likely to be positive to SARS-CoV-2 (F = 2.546, p <005). The specific mortality rate was 13%. Severity at admission is related to mortality, at the rate of a higher score on the APACHE II scale, higher mortality rate (r = 0.64, p <0.05, see figure 1). Low levels of PaO2 / FiO2 and high blood pressure figures carbon dioxide (PaCO2), were also associated with a greater mortality (r = 0.49 and r = 0.41, p <0.05).

Complications detected during the study included facial edema in all patients on mechanical ventilation, lacerations to ears and cheekbones due to insufficient protection (lack of pads anti sores) and mobilization of central venous catheter.

Figure 1. Correlation between severity at patient admission and mortality. The higher the APACHE II score, the higher the mortality



Discussion

The present study agrees with the findings of other authors, regarding the improvement in gas exchange in patients with distress syndrome acute respiratory diseases that are subjected to mechanical ventilation, and mobilized to prone position. How it happened in the work of Cabrera-Rayo et al., in 100% of the patients achieved a statistically significant increase in oxygen saturation (SatO2) and in the ratio of blood pressure to oxygen and inspired fraction of oxygen (PaO2 / FiO2).[14]

These same findings are also endorsed by Accoce et al., who showed that the decubitus position prone allows a considerable increase of arterial saturation and concentration oxygen, without affecting the parameters ventilatory.[15]

With the data recorded in the present study, the favorable effects that allows prone position on the parameters ventilatory are an increase of PaO2 / FiO2 equal to or greater than 20%, an increase in PaO2 equal to or greater 10 mmHg. The response to decubitus prone is observed in 100% of patients with distress syndrome acute respiratory and nonresponders, generally have no deterioration blood gas nor do they need an increase in FiO2.

The suggested duration of the treatment in the prone position, according to experience obtained in the present study, it's 16 hours, reaching the peak maximum at 12 o'clock and being able to return supine after 16 hours, no risk of loss of benefits obtained in the prone position.

To prevent adverse effects, before placing ARDS patients in the prone position, a multidisciplinary effort by the nurses, doctors and orderlies for this maneuver to take place with the utmost care and safety. What's more, as Blanco and Moreno advise, patients should be held in position anti-Trendelenburg, perform rotations sides of the head every 2 hours and placement of colloid dressings in pressure sites,[16] this with the purpose to avoid the most complications frequent prone position, such as lacerations and pressure ulcers.

Conclusions

The prone position can significantly improve the values of PaO2, PaCO2, SatO2, as well as the PaO2 / FiO2 ratio, and in general the state of the patient with ARDS. In patients with ARDS, severity at the time of care is related to higher mortality. The main complications of prone decubitus have to do with facial edema and increased risk of pressure ulcers, not existing Considerable hemodynamic risks. Given the beneficial effects of prone position in patients with ARDS, it is considered good practice to perform this maneuver in patients with this Medical diagnostic.

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