Indian Journal of Basic and Applied Medical Research; March 2021: Vol.-10, Issue- 2, P. 87 – 94
DOI: 10.36848/IJBAMR/2020/26215.55605

Original research article

Prone position ventilation in Covid-19 ARDS patients- A prospective study

[1]DR .N. KRISHNA KUMAR, [2]DR.T.RAVI KUMAR, [3] DR.S.RAMKUMAR, [4] DR. M.RAVEENDRAN

[1]ASSISTANT PROFESSOR OF MEDICINE,
KMCH INSTITUTE OF HEALTH SCIENCES AND RESEARCH, COIMBATORE
[2] PROFESSOR OF MEDICINE AND MEDICAL SUPERINTENDENT
GOVERNMENT MEDICAL COLLEGE AND E.S.I. HOSPITAL, COIMBATORE-15
[3] PROFESSOR AND HOD OF MEDICINE,
KMCH INSTITUTE OF HEALTH SCIENCES AND RESEARCH,
[4] DEAN & PROFESSOR OF MEDICINE,
GOVERNMENT MEDICAL COLLEGE AND E.S.I. HOSPITAL, COIMBATORE-15
* CORRESPONDING AUTHOR

Abstract

Introduction: SARS-CoV-2 virus causes a pneumonia that was identified through fever, dyspnoea, and acute respiratory symptoms and named COVID-19. This disease exacerbates in a number of patients and causes pulmonary edema, multi-organ failure, and acute respiratory distress syndrome (ARDS). Prevalence of ARDS among COVID-19 patients has been reported to be up to 17%. In the absence of effective targeted therapies for COVID-19, optimisation of supportive care is essential. micro vascular thrombi, Lung injury with features of acute respiratory distress syndrome (ARDS) appears to be the principal characteristic of severe acute respiratory syndrome corona virus 2 infection Among treatment methods for management of ARDS patients, prone position can be used as an adjuvant therapy for improving ventilation in these patients

Aim : To find out the beneficial effects of prone position ventilation in COVID-19 patients ARDS. Presently, no published trials investigate the effectiveness of prone positioning in awake patients with typical ARDS

Material and methods: Patients admitted in various tertiary care COVID-19 hospitals in coimbatore are taken for study . totally 300 patients on ventilators , invasive and non invasive ventilation are taken for study. Study period 1 st March 2020 to 28 th February 2021.

Results: Totally 14,876 patients admitted during study period 721 patients went for ARDS ,of which we randomly select 300 patients for this study.MALE, 183 FEMALE, 117 included in studythose who can be put and toletate more than 16 hours prone position per day improved very much 92-96% those who between 16-12- hours improved 88% 12-6 hours improved 78 % less than 6 hours improved 72 %, it requires lot of manpower, commitment and skilled staff in IMCU to implement prone position ventilation.

Conclusion; prone position ventilation is very much useful in COVID-19 ARDS,pneumonia, in invasive ventilation as well as non invasive ventilation.

Key Words: COVID-19, ARDS, prone position, Acute respiratory distress syndrome

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INTRODUCTION:

SARS-CoV-2 virus causes a pneumonia that was identified through fever, dyspnoea, and acute respiratory symptoms and named COVID-19. This disease exacerbates in a number of patients and causes pulmonary edema, multi-organ failure, and acute respiratory distress syndrome (ARDS). Prevalence of ARDS among COVID-19 patients has been reported to be up to 17%. In the absence of effective targeted therapies for COVID-19, optimisation of supportive care is essential. micro vascular thrombi, Lung injury with features of acute respiratory distress syndrome (ARDS) appears to be the principal characteristic of severe acute respiratory syndrome corona virus 2 infection Among treatment methods for management of ARDS patients, prone position can be used as an adjuvant therapy for improving ventilation in these patients. With this objective , we planned to find out the beneficial effects of prone position ventilation in COVID-19 patients ARDS. Presently, no published trials investigate the effectiveness of prone positioning in awake patients with typical ARDS.

MATERIAL AND METHODS:

Patients admitted in various tertiary care COVID-19 hospitals in coimbatore are taken for study . totally 300 patients on ventilators , invasive and non invasive ventilation are taken for study. Study period 1 st March 2020 to 28 th February 2021.

Totally 14,876 patients admitted during study period 721 patients went for ARDS, of which we randomly select 300 patients for this study.

The study was conducted in our Department. Sample size estimation was confirmed from expert.

RESULTS:

TABLE 1: Age distribution

Age Group	Number of Patients	Percentage
<40 Years	72	24%
41-50 Years	102	34%
51-60 Years	54	19%
61-70 Years	60	15%
71-80 Years	12	4%
81-90 Years	9	3%
>91 Years	3	1%

TABLE 2: Sex distribution

Sex	No of Patients	Percentage
Male	183	61%
Female	117	39%

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Table 3) Patients improvement duration

Pp duration	improvement
>16 hours	96%
16-12 hours	88%
12-6hours	78%
<6hours	72%

Totally 14,876 patients admitted during study period 721(4.5%)patients went for ARDS , totally 300 patients ,MALE, 183 FEMALE, 117 taken for this study . those who can be put on more than 16 hours prone position per day improved very much 92-96% those who between 16-12- hours improved 88% 12-6 hours improved 78 % less than 6 hours improved 72 %, it requires lot of manpower, commitment and skilled staff in IMCU to implement prone position ventilation.

DISCUSSION:

COVID-19 pademic ,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, dyspnoea, and acute respiratory symptoms and named COVID-19. This disease exacerbates in a number of patients and causes pulmonary edema, multi-organ failure, and acute respiratory distress syndrome (ARDS). Prevalence of ARDS among COVID-19 patients has been reported to be up to 17%

Helping a patient through the process of attaining the prone position will require four people who are well-versed with the technique. While the first one will stand close to the head and will take care of the endotracheal tube, the second one will be responsible for taking care of various connections to the body, such as the catheter, drains, etc. The other two will stand one at each side of the bed, that is, the left and the right. Their job will be to turn the patient in the required direction. The first person should also be prepared to help with the removal of excess secretion, which is produced as a result of the prone position.

The patient is turned such that he/she attains lateral decubitus position as the initial stage. In this position, the person lies on the left side. Place both the hands of the patient along the respective sides. Turn the patient along one side and connect the electrodes for cardiac monitoring at the back. In case the process does not serve its purpose, you can also use abdominal suspension.

The people administering the technique should ensure that the endotracheal tube is fixed 2 cm above the Carina in order to reduce the chances of complications. Also, they must ensure that there no presence of foreign particle, which might obstruct the process of eternal feeding. The position of the head of the patient should be changed every 2 to 4 hours in order to avoid discomfort.

Advantages of Prone Position

Besides the improvement in oxygenation, the prone position offers many other advantages to the patient. It improves the functional residual capacity of the lungs, thereby, reducing the chances of abdomen expansion during the position. It reduces the chances of lung collapse due to internal factors and enables them to inflate even at low

pressures. It also enhances the alveolar ventilation and makes it more consistent in nature. In this position, the heart basically relies on the right lung instead of the left one, thus, reducing the compression rate on the lungs. This position also decreases the posterior atelectatic lung, which tends to make the lungs more compliant in addition to enhancing the ventilation-perfusion matching. The prone position does not have any negative impact on the respiratory mechanics, instead, improves it.

Potential Sources of Injury in Prone Position

1. Patient must be first examined for his/her ability to bear the prone position.
2. The staff must ensure not to apply too much pressure, especially on the delicate and small parts of the body such eyes, ears, nose, etc. Excess pressure may lead to damage of the body part. This pressure may not only be applied through the hands, it may also be a result of the obstruction caused by the arterial supply or venous drainage.
3. The dependent areas such as nose, forehead, breast, arms, chest, genitalia, and pelvis must be properly noted and addressed.
4. Direct pressure may lead to damage of the nerves. It should be taken care that nerves are applied with appropriate pressure only.
5. Ocular damage might be a result of two factors. The first one might be excess pressure on the eyes, while the second one being poor perfusion. This may lead to severe damages, hence, it should be well taken care of.
6. Too much pressure can be transferred from the lower and upper limbs to the head, neck, chest, abdomen, and vessels. This may cause the corresponding areas to swell, thus, producing obstructions to the air flow.

Prone Positioning Checklist

A checklist ensures that the complications associated with prone positioning can be avoided. It includes following steps

Identify the team members and make sure that everyone has been assigned their task in order to avoid confusion during the process.

1. Identify the connections to the patient's body and make sure they do not face any blockage.
2. Make sure you provide cushions wherever necessary. It not only ensures the patient's comfort, but also reduces the chances of extra pressure on the smaller parts of the body.
3. All the test that should have be conducted prior to the commencement of prone positioning should be performed by the nursing staff, and same should be checked by the higher authorities involved.
4. The team must ensure coordination between the team members.

Duration of Prone Positioning

Ideally, there is no specific duration for which the person should be under prone position. There have been cases in which the conditions have seen improvement once the patient is in prone condition, but once repositioned to supine position, the condition deteriorated again. Therefore, it is advisable that the person should be allowed to stay in prone position until the condition has completely stabilized

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The term ARDS was first introduced in 1968 with clinical presentations such as acute 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 introduced treatment methods for management of ARDS patients, prone position can be used as an adjuvant therapy for improving ventilation in these patients. It should be prescribed along with low tidal volume (6 cc per kg body weight) and 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 elasticity, decreasing alveolar shunt, and improving tidal volume . Patients remaining in lengthy prone position sessions lead to decrease in mortality of patients .

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 . Additionally, in another meta-analysis it was revealed that prone position can only reduce mortality due to ARDS when patients are ventilated with low tidal volume, the treatment is started within the initial 48 hours of initiation of the disease, and patients have severe hypoxia. In other words, prone position can reduce mortality only when prescribed for patients with severe impaired oxygenation, in the initial hours, and for long durations

Recently, in a multi-centered observational study, Guérin et al. showed that only 13.7% of patients with ARDS have been placed in prone position. Even in patients with severe ARDS, the rate of using this technique was 32.9%. In the mentioned study, 2 main reasons were given for the physicians' reluctance to use this treatment method: 1- Based on the judgment of the physicians in most cases, the hypoxia in severe ARDS patients is not severe enough to justify using prone position. 2- Most ARDS patients have hemodynamic instability, which prevents the physicians from deciding to use prone position .

In addition to the effectiveness of this treatment method, caretaking aspects and the side effects of this position on ARDS patients should also be considered. Patients that undergo ventilation with ventilator in prone position face risks such as accidental removal of the tracheal tube, limited access to the venous route, bending or pulling of the catheters and chest tube, pressure wound, bruising around the mouth due to presence of the tracheal tube, edema around the eyes and facial edema, Gastroesophageal reflux, hyper-salivation and skin injuries . In prone position, the patient should face the ventilator and in patients with tracheostomy, a roll of fabric or pillow should be placed under the shoulders to prevent airway obstruction, these patients should receive muscle and nerve relaxant medications and high-dose sedation as infusion, eye pads should be used for closing the patients' eyes to prevent corneal ulcers.

Considering the condition of these patients and presence of pressure on their stomach, the probability of reflux after lavage is very high, so they must be closely monitored regarding aspiration of gastric contents

The position of patients placed in prone position should be changed every 2 hours and sides should be switched. At least 3 to 5 individuals should participate to correctly put intubated patients in prone position, which is a serious limitation for keeping the patient in this position for a long time.

Overall, it seems that studies on the effectiveness of prone position in ARDS patients clearly point out that correct patient selection, timely initiation and duration of patient's placement in this position can all affect the effectiveness of this treatment method. Available meta-analyses show that prone position can decrease mortality in ARDS patients when performed in the initial hours of disease manifestation, in patients with severe impaired oxygenation and for a long time . The minimum suggested duration of prone position is 12 hours a day.

Recent guidance by the UK Intensive Care Society (ICS) advocates awake prone positioning to become standard of care for suspected or confirmed COVID-19, in patients requiring an FiO_2 ≥28% These recommendations are extrapolated from physiological principles and clinical evidence obtained in a distinct study population—patients with severe ARDS undergoing invasive mechanical ventilation (IMV).

The physiological rationale behind prone positioning in typical ARDS is to reduce ventilation/perfusion mismatching, hypoxaemia and shunting. Prone positioning decreases the pleural pressure gradient between dependent and non-dependent lung regions as a result of gravitational effects and conformational shape matching of the lung to the chest cavity. This is believed to generate more homogenous lung aeration and strain distribution, thus enhancing recruitment of dorsal lung units. Prone positioning does not appear to alter regional distribution of pulmonary blood flow, with perfusion predominating towards dorsal lung aspects due to non-gravitational factors. With improvements in ventilatory homogeneity and relatively constant perfusion patterns, a subsequent reduction in shunting is observed. The use of positive end-expiratory pressure via non-invasive ventilation (NIV) or CPAP in the management of ARDS is beneficial by preventing alveolar de-recruitment but may also result in over distension of previously well-ventilated alveoli. Similarly, spontaneously breathing patients in acute hypoxaemic respiratory failure can generate high respiratory drives and forceful inspiratory efforts that lead to lung injury reminiscent of ventilator-induced lung injury. Prone positioning in these patients and in combination with NIV/CPAP may help to mitigate this detrimental effect in part by reducing regional hyperinflation. Prone positioning is an established evidence-based practice in patients with typical ARDS undergoing IMV, but limited evidence exists in non-ventilated awake patients. In a multicentre, randomized controlled trial of patients with severe ARDS receiving IMV, prone positioning halved 28-day mortality rates (16% vs 32.8%, $p<0.001$) with no additional complications. Meta-analyses suggest that early prone positioning for 12–16 hours/day combined with low tidal volume IMV reduces mortality in severe hypoxic respiratory failure.

. These reports demonstrated short-term improvements in oxygen requirements (PaO_2) and demand (FiO_2) with no harm to patients. Valter *et al* applied prone positioning to four patients with indications for IMV and found rapid improvements in PaO_2—all patients avoided IMV and tolerated prone positioning well. In an observational study of 15 patients receiving non-invasive respiratory support for acute hypoxaemic respiratory failure, repeated prone positioning led to transient but substantial improvements in oxygenation. In a prospective observational study of 20

patients receiving non-invasive ventilation for moderate-to-severe ARDS, PaO_2/FiO_2 ratio increased by 25–35 mm Hg following awake prone positioning; but 78% of participants with severe ARDS eventually required IMV, and therefore awake prone positioning should not delay the use of IMV when indicated.

The notion of applying evidence generated in typical ARDS universally to patients with COVID-19 is challenged by Gattinoni *et al* based on their analysis of 150 patients. They hypothesize lung injury in COVID-19 to encompass a time-dependent spectrum of disease with variable patterns of lung pathology and heterogenous responses to prone positioning.

In early phases of COVID-19 pneumonitis, lung compliance is proposed to be high, recruit ability minimal and hypoxaemia predominantly driven by impaired regulation of pulmonary perfusion patterns. Awake prone positioning here could temporarily improve ventilation/perfusion mismatch, but sustained benefits in highly compliant lungs are unlikely.17 With disease progression, COVID-19 pneumonitis is thought to gradually start behaving like typical ARDS, demonstrating lower compliance and higher recruitability with a more favorable long-term response to prone positioning. It is suggested that phases of COVID-19 pneumonitis may be distinguished prior to intubation using CT measurement of lung weight, gas volume and proportion of non-aerated tissue, although additional large studies are required to validate this diagnostic modality.17 During a pandemic, application of CT scanning to all patients with COVID-19 for this purpose is unlikely to be feasible and will bear future risks related to radiation exposure. Further work to confirm or refute the hypothesis put forward by Gattinoni *et al* is needed. Estimating the frequency and speed of phase transition as well as identifying pragmatic surrogate markers to predict disease phase may be useful in selecting those who could benefit the most from awake prone positioning.

Furthermore, the minimum duration requirements for maintaining the prone position in awake patients to engender clinically meaningful benefits remain undefined. Durations comparable to those necessary for patients undergoing IMV (12–16 hours/day) may be difficult to achieve. For instance, the longest duration of prone positioning achieved in observational studies of awake patients was 8 hours. Improved lung secretion drainage under gravitational forces and increased coughing following prone positioning may contribute to viral contamination of the patient environment, necessitating the use of adequate personal protective equipment during patient contact.

Conclusion

In summary, awake prone positioning appears to be safe and may slow the respiratory deterioration in select patients with COVID-19, who require oxygen supplementation or NIV/CPAP. This in turn may reduce demand for IMV, easing the strain placed on intensive care services around the world. In resource-limited settings, this simple, low-cost intervention may serve to raise the ceiling of care for patients that might otherwise have no further option. Presently, uncertainties surrounding the effectiveness of awake prone positioning in ARDS and COVID-19 are substantial. High-quality studies are required to assess the degree to which awake prone positioning may be beneficial, as well as select those who may benefit from it the most.

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Author Declaration: Source of support: Nil, Conflict of interest: Nil
Ethics Committee Approval obtained for this study? YES
Was informed consent obtained from the subjects involved in the study? YES
For any images presented appropriate consent has been obtained from the subjects: YES
Plagiarism Checked: Urkund Software

DOI: 10.36848/IJBAMR/2020/26215.55605