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Automated Proning Computer Controlled Mechanical Bed, The Rotoprone® in Treatment of COVID 19 with Severe ARDS Practical Field Perspectives in the Middle of a Pandemic.

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Patient: Male, 47-year-Old

Final Diagnoses: ARDS, Rotoprone®, Prone Position, VQ Mismatch, Covid 19

Symptoms: Hypotension, tachycardia, hypoxemia, refractory hypoxemia, shock

Medication: Remdesivir and Dexamethasone

Clinical Procedure: Mechanical ventilation, Prone ventilation, Prone Position, mechanical ventilation.

Specialty: Pulmonary, Critical Care & Health Care Management.

MeSH Keywords: COVID 19, endotracheal intubation, Rotoprone®, ARDS, Hypoxic respiratory failure, Prone Ventilation, Proning, Trauma, Prone Position, ECMO

Objective: Unusual clinical course

Background:

We report a case of a patient's survival after presentation with acute hypoxemic respiratory failure and refractive hypoxemia.

We treated the patient, with mechanical ventilation and Rotoprone® for prone ventilation for a period of 16 hours per day, anticoagulation, Remdesivir and dexamethasone standard COVID therapy. The patient had high Peep, low tidal volume and protective lung therapy. After prolonged mechanical ventilation for 2 weeks and the use of the Rotoprone, the patient was weaned and eventually survived hospitalization.

We were able to keep the patient supine with an improved pa02/ fio2 ratio> 150, prone ventilation was stopped and subsequently, patient was extubated. The patient had a tracheostomy and peg tube, 21 days later and was discharged from the intensive care unit (ICU) to a long-term care facility. Prone position has been a proven technique to improve oxygenation in ARDS respiratory failure during the pandemic in both the intubated and non-intubated patients. The technique is used to treat hypoxic non intubated patients on medical floors and moderate to severe ARDS patients on mechanical ventilation in the intensive care units.

The original description of the prone position goes back to 1977. Where arterial oxygen tension was shown to improve after prone position in moderate ARDS patients receiving mechanical ventilation. Proning helps by decreasing ventilation/perfusion heterogeneity, it decreases the pleural pressure and increases the regional ventilation in the dependent lung regions near the diaphragm. Proning also helps in reducing airway closure in dorsal lung regions, improves secretions removal and increases the functional residual capacity with improvement in the redistribution of blood. Overall, the proning of patients increased the lung volumes up to 17 percent, this recruits more lung tissue allowing for a better, VQ match (Ventilation Perfusion match), making a heterogeneous lung into a more homogeneous state. Acute Respiratory Distress Syndrome (ARDS), in the United States, ranges from 64.2 to 78.9 cases/100,000 person/year. The mortality rate of ARDS is commensurate to the severity of the symptoms; the rate ranging from 27%, 32%, and 45% for mild, moderate, and severe diseases, respectively.

Mechanical pronation beds have impacted the care of individuals admitted to acute care facilities with ARDS and acute lung injury. These beds can tilt the patient to a prone position. They facilitate the management of endotracheal tubes, intravenous lines (IVs) and other equipment to prevent tangles and kinks or unintentional disconnection of necessary devices.

Figure 1: Supine vs. prone pressure from the heart

Note. From "Efficacy of prone position in acute respiratory distress syndrome patients: A pathophysiology-based review," by Koulouras, V., Papathanakos, G., Papathanasiou, A., & Nakos, G. (2016). World Journal of Critical Care Medicine, 5(2), 121–136. (https://doi.org/10.5492/wjccm.v5.i2.121). Copyright 2016 by Baishideng Publishing Group Inc.

The recent Sars-CoV-2 virus spread in the US has increased the demand for specialty care, nurses, therapist, and Physicians. Prone ventilation is work intensive and requires many people to safely rotate the patient. Prone ventilation can improve the ventilation-perfusion ratio and improve oxygenation as shown in many cases of COVID-related ARDS, but the lack of manpower has made it very labor-intensive. **Figure 1**. Therefore, any mechanical device that can improve oxygenation without increasing manual labor for staff and reducing the time taken away from patient care is always welcomed at this point of the pandemic. **Table 1 and 2**.

The Rotoprone® is an effective way to provide prone ventilation. Currently, with high numbers of COVID-19 patients, the United States Intensive Care Units (ICU) are getting over 100.000 admissions and over 90 percent require ICU care. The capacities in the southern US are saturated with patients and they lack personnel. A mechanical bed can reduce the time and burden to staff while providing an effective way to oxygenate these patients.

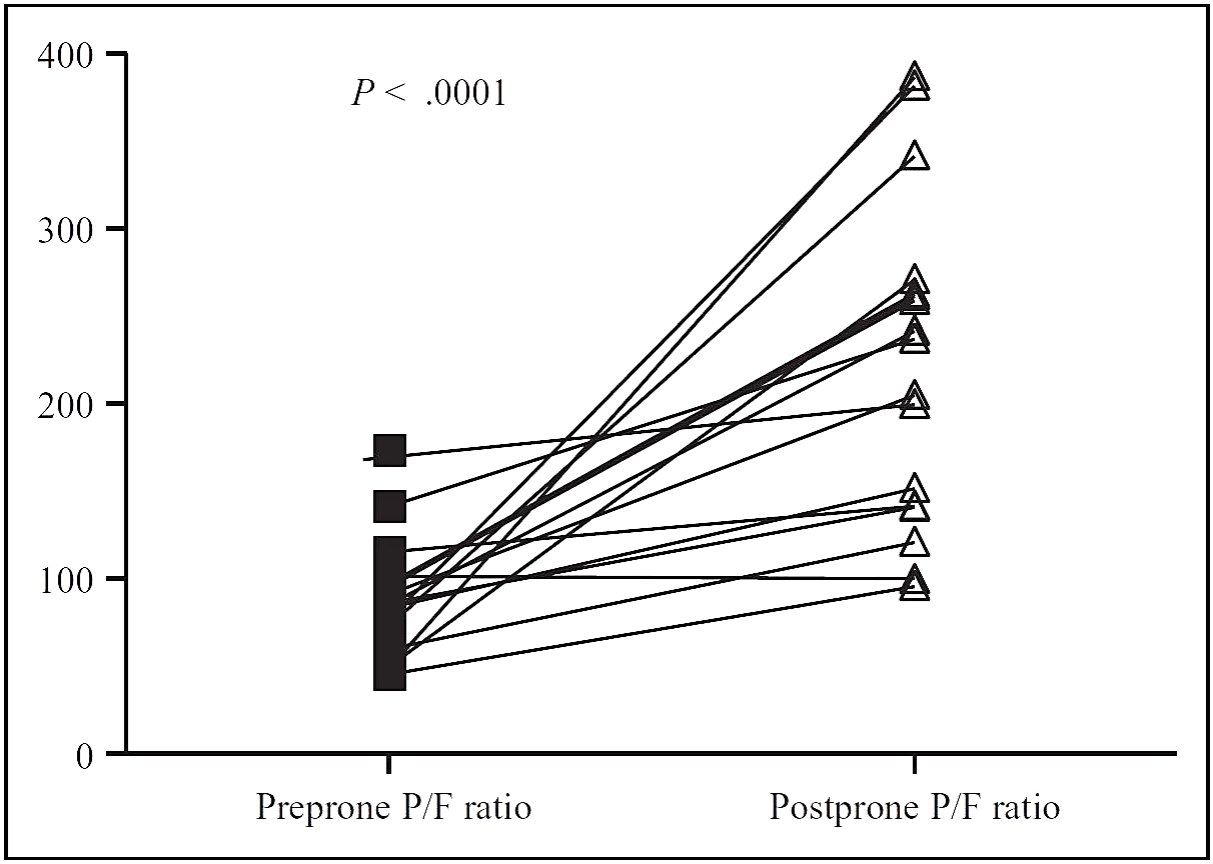

Table 1. "Automated prone positioning and axial rotation in critically ill, nontrauma patients with acute respiratory distress syndrome (ARDS)" results*

Note. From "Automated prone positioning and axial rotation in critically ill, no trauma patients with acute respiratory distress syndrome (ARDS)," by Bajwa, A. A., Arasi, L., Canabal, J. M., & Kramer, D. J. (2010). Journal of Intensive Care Medicine, 25(2), 121–125. (https://doi.org/10.1177/0885066609356050.) Copyright 2021 by SAGE Publications

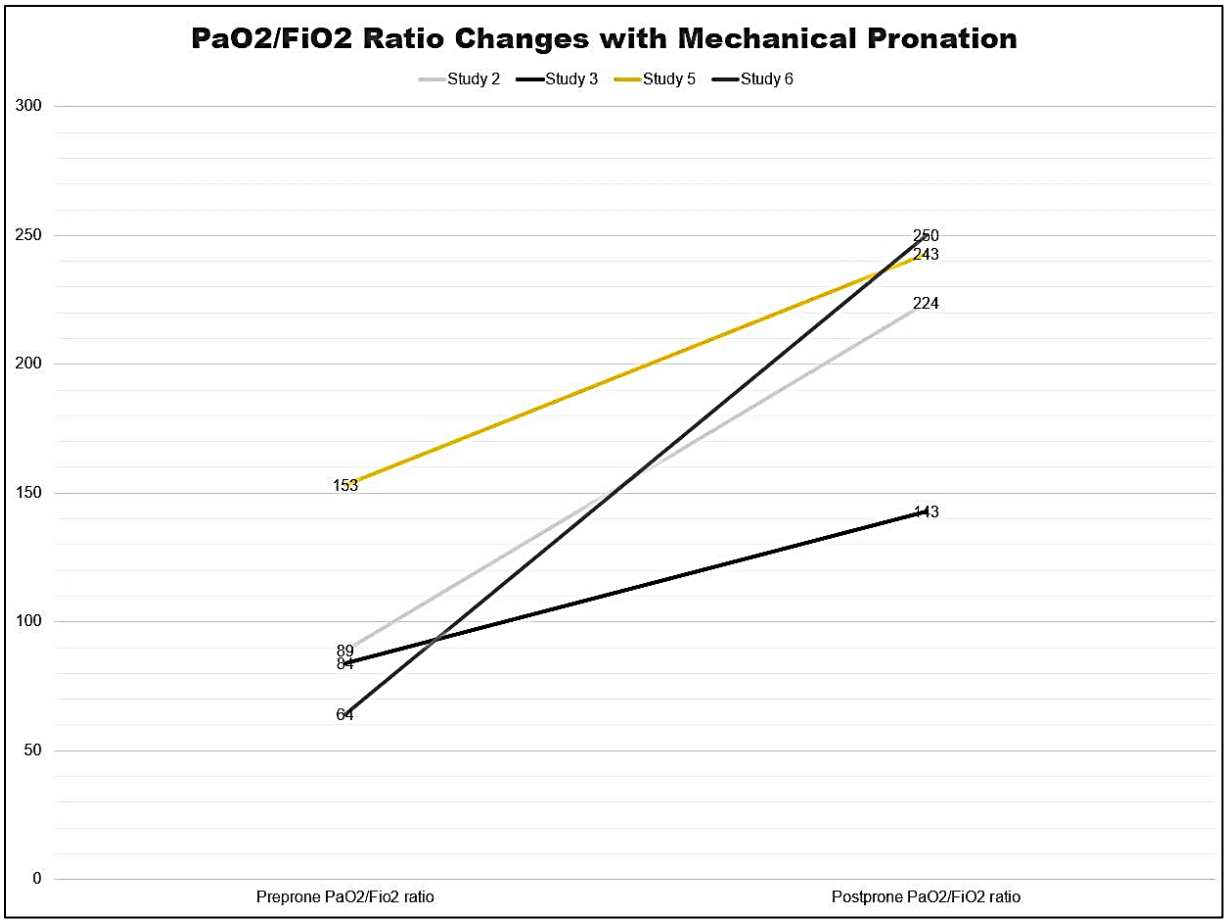

Table 2. PaO2/FiO2 ratio changes with mechanical pronation*

Note. Derived from:

"Automated prone positioning and axial rotation in critically ill, nontrauma patients with acute respiratory distress syndrome (ARDS)," by Bajwa, A. A., Arasi, L., Canabal, J. M., & Kramer, D. J. (2010). Journal of Intensive Care Medicine, 25(2), 121–125. (https://doi.org/10.1177/0885066609356050)

"Pronation therapy case report: Nurse's perspective and lessons learned," by Berry, K., BSN, RN. (2015). Dimensions of Critical Care Nursing, 34, 321-328. (https://doi.org/10.1097/DCC.0000000000000142)

"Prone ventilation in trauma or surgical patients with acute lung injury and adult respiratory distress syndrome: Is it beneficial?" by Davis, J. W., Lemaster, D.M., Moore, E. C., Eghbalieh, B., Bilello, J. F., Townsend, R. N., Parks, S. N., & Veneman, W. L. (2007). Journal of Trauma, 62(5), 1201–1206. (https://doi.org/10.1097/ta.0b013e31804d490b)

"Successful use of an automated proning system to achieve prone positioning in a patient with severe ARDS requiring veno-venous ECMO," by Lehr, A. L., Smith, D. E., Toy, B., Goldenberg, R., & Brosnahan, S. B. (2020). Respiratory Medicine Case Reports, 31, 101315. (https://doi.org/10.1016/j.rmcr.2020.101315)

Case Report

A 47-year-old male presented to the emergency room after practicing social distancing for over two months due to COVID-19. The patient complains of cough, fever, and progressive shortness of breath (SOB). The patient did not get vaccinated. The patient was seen in the emergency room, he presented with increased oxygen requirements and low saturations of 85% that corrected with initial supplemental oxygen 5 liters to 91%. Chest X-Ray (CXR) reveals bilateral ground-glass opacities. Despite the initiation of steroids, Remdesivir and antibiotics, his overall condition continued to decline. A CTA of the chest was ordered that demonstrated bilateral pulmonary ground-glass opacities with no evidence of pulmonary embolism. The patient was a tachycardiac and despite administering additional fluids and oxygen, he required mechanical ventilation and endotracheal intubation. The patient was placed on the ventilator; he was found to be in hypotensive shock and hypoxic. His initial mechanical ventilation settings were in assist control mode 16 with a peep of 10 and 100% of oxygen. His ABGs, was 7.52, pco2 34 po2 53 %. The peep was titrated to 16, the patient was paralyzed with rocuronium and subsequently prone on a Rotoprone®. Po2 subsequently post Rotoprone®, high PEEP low tidal volume and plateau pressure of 30 mmHG, his Po2 improved to 159 in the prone position. Overnight saturation improved and over the next 21 days, his CXR showed improvement. The patient had a tracheostomy and peg tube placement, he was discharged from the acute care hospital to a long term care facility to continue with his care.

Discussion

Prone ventilation on non-intubated and ventilated patients with ARDS has been shown to improve oxygenation and it is an active way to treat COVID-19 hypoxic respiratory failure induced ARDS. Manual pronation of turning a patient from the supine to the prone position, is labor intensive requiring from 3 to 6 people and a respiratory therapist to manage the endotracheal tube. Strategically placing of pillows and a sheet which will end up below the patient being pronated requires time and staff that is needed to care for critical patients. The individual is first turned to the side and a safety check is performed to ensure all the lines have slack. The respiratory therapist keeps an eye on the ETT tube and then after all the lines have been checked, the rotation is completed and the patient is in prone position. Considering in most protocols you want to at least prone patients for 14 to 16 hours you may have to repeat this procedure at least 3 times in a 24-hour period. Mechanical pronation beds are designed to alleviate the labor required to turn a patient to prone position and are designed specifically for acute care. The Rotoprone® acts by slowly moving the patient into position, it has padding for support of multiple areas such as the face chest and back. Nurses can still take care of the skin and assess the lines and endotracheal tube as needed. The mechanical bed has spaces for ventilation equipment management and IV management. There are fasteners securing the patient into the bed assuring a safe and smooth transition from supine to prone with the fewer medical staff needed to assist. The bed itself

has a computer timer that alerts when to change position and with a joystick or pad controller, any nurse or healthcare provider can prone a patient even with BMI >30, morbidly obese with ease and safety. In fact, morbidly obese patients have been shown to benefit even more than non-obese patients in prone ventilation with ARDS.

Obese patients could be a subgroup of patients with ARDS who may benefit the most from prone positioning.

Since manual pronation therapy involves caregivers physically turning patients, physical injury of staff can occur as well as increased risk of accidentally extubating and dislodging arterial or venous lines needed for the proper management of the patient. Not only is the patient at risk for injury at the time of rotation, but also the nurses and staff are also at risk of injury especially with the higher BMI patients that we are seeing with COVID-19 related ARDS. Mechanical pronation devices have tube management systems at both ends of the bed, which creates less movement of the patient's tubing and any lines around the bed during pronation. This results in a decreased risk of unintentional extubating and accidental line dislodgement.

Conclusion

Mechanical Pronation therapy is an effective method to transition individuals with severe ARDS from a supine to a prone position. This allows for the prompt improvement of ventilation-perfusion in a disease like COVID-19 induced hypoxic respiratory failure, it is an active tool in acute resuscitation. The prompt pronation in trauma induce ARDS is also beneficial and has been shown to reduce mortality. To place a patient directly on a Rotoprone® from the time of admission in the emergency room or while in a trauma bed after securing lines and intubation will improve ventilation-perfusion and improve Po2 compared to straight supine ventilation. Mechanically prone ventilation can reduce the potential injury from lines and endotracheal tube unintentional dislodgment and injuries to the healthcare team. Prone ventilation has also shown the benefit of shorter recovery periods in some patients with ARDS and decreased mortality.

Pronation and ECMO have also been reported in case reports as beneficial. The Rotoprone® machine has a computer system that allows the user to extend the pronation in cases of refractory hypoxemia due to ARDS or for a quick change in position for interventions like placing chest tubes, lines, or draining of spaces at the bedside. In some community hospitals, the cost per day of a mechanical bed may be 1.000 USD per day per rental fees or leasing agreements. This cost may still be justified if prevents the loss of life or loss of an injured staff that can help other patients in times of shortage of healthcare providers. IF you factor the cost of 3 to 6 healthcare workers during at least 3 trials of moving the patient over a 24-hour period of time. Compounded by some regions in the US being short of ICU nurses, where

the nurses are managing more critical patients than normal. The use of mechanical beds has increased the safety of the patient while preventing potential injuries to nurses who are already overworked and a scarce resource. Nurses, respiratory therapists, and ICU personnel should be trained in the benefits of pronation and the current setup of mechanical Pronation. **Figure 2, 3**.

Figure 2. Rotoprone® with the head piece open allowing the physician to place Central lines, hemodialysis catheters and if needed change of an endotracheal tube while patient still in the Rotoprone®.

Figure 3. The Rotoprone® and Prone Ventilation in a Sars-CoV-2 virus infection induced ARDS.

Conflict of Interest

NONE.

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