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Case Report

Prone ventilation in COVID-19 acute respiratory distress syndrome: Case report of two patients from Ethiopia

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ABSTRACT

The COVID-19 pandemic is one of the largest health crises that the world has ever seen, infecting forty million people and killing more than 1 million to date. The disease has imposed a significant demand on health care resources due to the increased number and severely ill patients visiting facilities each day. Since there is no effective cure for COVID-19, supportive management with oxygen, steroids, anticoagulation, and prone positioning remains the major interventions. Prone ventilation is known to have a mortality benefit in intubated patients with acute respiratory distress syndrome (ARDS). However, studies on its role in intubated patients with COVID-19 ARDS (CARDS) are very scarce in resource-limited settings like Africa. We describe two patients with CARDS who were successfully treated with invasive mechanical ventilation, prone ventilation, and standard supportive care.

Keywords: Acute respiratory distress syndrome, COVID-19, Prone ventilation

INTRODUCTION

COVID-19 can result in severe respiratory failure associated with a high mortality rate, ranging from 40% to 80%, depending on the reporting country.[1] Management remains supportive with respiratory care focused on improved gas exchange and reduced respiratory distress.

Prone ventilation was first used in 1977 to improve arterial oxygenation in patients with acute respiratory distress syndrome (ARDS).[2] The PROSEVA trial in 2013 demonstrated improved oxygenation and a 16% absolute risk reduction in mortality utilizing prone ventilation in patients with moderate-severe ARDS.[3]

Recently, prone ventilation has been widely used in both intubated and non-intubated patients with COVID-19.[4] In a time when critical care medicine is challenged and the prognosis of those with severe COVID-19 remains poor, treatment strategies that are lifesaving, feasible, and affordable are of paramount importance, especially in low- and middle-income countries (LMIC). Prone ventilation is one such strategy. We report two cases of COVID ARDS (CARDS) who were successfully treated with prone ventilation, resulting in full recovery at Eka Kotebe Hospital Intensive Care Unit (ICU), a 12 bed closed ICU staffed by attending physicians and residents from the College of Health Sciences of Addis Ababa University, and nurses experienced in emergency and critical care medicine.

CASE REPORT

Case 1

A 55-year-old woman with known diabetes, dyslipidemia, and schizophrenia was admitted to a local hospital with a 3-day history of shortness of breath, non-productive cough, and fatigue. Several days later, she was transferred to Eka Kotebe Hospital, the COVID-19 specialized hospital in Addis Ababa, because of worsening respiratory status. At presentation, she was tachycardic (heart rate [HR] 112/min), tachypneic (respiratory rate [RR] 36/min), and hypoxemic, desaturating (oxygen saturation [SPO_2] 80%) despite supplemental oxygen at 5 L/min. Initial laboratories included: Positive reverse transcription-polymerase chain reaction (RT-qPCR), mild lymphopenia (1.3×10^9/l), thrombocytopenia (1.07×10^9/l), moderate hypokalemia (K^+ - 2.9 meq/L), and hypernatremia (Na^+ - 151 meq/L); her renal function tests, liver function tests, and urinalysis were normal. Her chest computed tomography showed bilateral peripheral-based diffuse patchy consolidation with pleural effusion and chest ultrasound revealed multiple B-lines bilaterally, and bedside echocardiography showed normal cardiac contractility and ejection fraction. She was diagnosed with CARDS.

Her respiratory status worsened; her oxygenation failed to improve despite the hospital standard protocol of awake prone ventilation, high flow supplemental oxygen (15–20 L/min) through a nasal cannula and then a face mask with and without a non-rebreather reservoir. Confusion precluded the use of the next protocol intervention of non-invasive positive pressure ventilation, and on Day #3 of hospitalization, she was transferred to the ICU for intubation, mechanical ventilation, and continued prone ventilation.

She was placed on assist control (AC)/volume control (VC) mode, RR 16/min, tidal volume (TV) 300 ml (6 ml/kg), peak end-expiratory pressure (PEEP) 14 cm H_2O, fraction of inspired oxygen (FiO_2) 1.0, and prone positioning for 16 h a day. The patient was also managed with antibiotics (cefepime, vancomycin), dexamethasone 6 mg IV/day, chloroquine 500 mg po/day, and propofol sedation. The initial arterial blood gas (ABG) analysis done after intubation on the above ventilator settings showed metabolic alkalosis (pH 7.48, $PaCO_2$ 39.2, PaO_2 87 mmHg, HCO_3 28.8 mEq/L, PaO_2/FiO_2 (P/F) ratio of 87, and lactate 1.5 mmol/L. On day #4, her plateau pressure (Plateau) remained over 30 cm H_2O pressure despite a low TV (4 ml/kg); her ventilator settings were adjusted to AC/pressure control mode with a driving pressure (DP) 14 cm H_2O, an inspiratory:expiratory (I:E) ratio 1:2, and PEEP 14 cm H_2O. On day #6, her FiO_2 was decreased progressively to 0.5, DP 14 cm H_2O, IT seconds, and PEEP 14 cm H_2O. Her repeat ABG on these ventilator setting revealed pH 7.48, $PaCO_2$ 44.8 mmHg, PaO_2 70 mmHg, HCO_3 33.2 mEq/L, and P/F ratio 140 [Table 1].

The remainder of her hospitalization was complicated by transaminitis, poor glycemic control, ventilator-associated pneumonia, aspiration pneumonia, and stridor after a first extubation attempt.

Her clinical status gradually improved and she was extubated and liberated from mechanical ventilation on day #18 of ICU care; she subsequently required only 2 L/min supplemental oxygen with improved ABGs [Table 1].

On day # 36 of hospitalization and the 18th day post-extubation, the patient was much improved with normal mental status, stable vital signs, and only intermittent use of supplemental oxygen. With two negative RT-qPCR for SARS-CoV-2, the patient was transferred to a non-COVID treatment center for further rehabilitation with an eventual return to home.

Case 2

A 42-year-old previously healthy man was hospitalized with symptoms of productive cough, shortness of breath, low-grade fever, and easy fatigability of 7 days duration. On admission to the Eka Kotebe Hospital, he was tachycardic (HR 120/min), tachypneic (RR 30–40/min), and hypoxemic (SaO_2 92% on 10 L/min supplemental oxygen). His initial laboratory investigations revealed leukocytosis (WBC 12.8 $\times 10^6$/l) with lymphopenia (1.21×10^9/l) and a lactate level of 2.0. Chest ultrasound showed bilateral multiple B-lines with no signs of heart failure on bedside echo. His first ABG on high flow supplemental oxygen (10 L/min) revealed pH 7.34, $PaCO_2$ 78 mmHg, PaO_2 31.3 mmHg, HCO_3 24 mEq/L, and P/F ratio of 112 [Table 2]. He was diagnosed with severe COVID-19 with superimposed bacterial pneumonia and started on cefepime, dexamethasone, therapeutic dose anticoagulation, and awake proning as tolerated (2–3 h of

Table 1: ABG analysis patient 1 – PNG.

Date	PH	PaO_2	$PaCO_2$	HCO_3	Lactate	Anion gap	P/F Ratio
1st day ICU (before proning)	7.48	52	39.2	28.8	1.5	9	37
3rd day ICU (after proning)	7.48	70	44.8	33.2	1.3	8	140
18th day ICU	7.41	82	39.2	23.6	1.7	12	231

Table 2: ABG analysis patient 2 – PNG.

Date	PH	PaO_2	$PaCO_2$	HCO_3	Lactate	Anion gap	P/F ratio
1st day ICU (before proning)	7.34	78	31.3	24	2	16	112
5th day ICU (before proning)	7.44	57	34	22.8	1.8	20	109
7th day ICU (before proning)	7.36	28	47.2	26.5	2.2	30	34
7th day ICU (after proning)	7.38	69	33.8	20.6	2.35	32	85
14th day ICU (before proning)	7.27	59	64.4	32.7	2.0	18	59
14th day ICU (after proning)	7.38	69	43.8	24.5	2.1	13	105

proning 5–6 sessions a day with 2–3 h interval in between the sessions).

Over the next 5 days, his respiratory condition worsened (RR 35–45) and he was unable to maintain adequate SPO_2 with high flow supplemental O_2 (15 L/min) with non-rebreather reservoir mask and subsequent non-invasive ventilation (bi-level positive airway pressure: Inspiratory positive airway pressure 20 cm H_2O and expiratory positive airway pressure 10 cm H_2O), and FiO_2 1.0. Later that day, he was intubated and placed on mechanical ventilation with the following settings: Pressure regulated VC mode, plateau < 30 cm H_2O, minute ventilation 6–10 L, RR 12/min, FiO_2 1.0, TV 5 ml/kg, and PEEP 14 cm H_2O. Prone ventilation was continued for 16 h each day for as long as he was intubated. Follow-up ABG on the above ventilator settings revealed pH 7.38, $PaCO_2$ mmHg, PaO_2 28 mmHg, HCO_3 26.5 mEq/L, and a P/F ratio 34 [Table 2].

Over the next 7 weeks, the patient experienced numerous complications, including hospital-acquired *Klebsiella pneumonia*, tracheoesophageal fistula, and a left-sided iatrogenic pneumothorax from invasive ventilation, which required tube thoracostomy. Despite these complications, the patient's respiratory status and gas exchange [Table 2] slowly improved; he underwent tracheostomy and was gradually weaned to a trach mask with 24–28% supplemental oxygen.

After 44 days total in the high dependency unit and in the ICU, and after two negative RTqPCR test results, he was finally transferred to a non-COVID hospital to complete his rehabilitation with intermittent 1 L/min nasal cannula O_2 support. Follow-up indicated ongoing clinical improvement with greater functionality not requiring supplemental oxygen and no evidence of chronic aspiration.

DISCUSSION

Interventions such as steroids, anticoagulation, antibiotics for secondary bacterial infection, and other routine ICU care likely contributed to the favorable outcome in our two patients with CARDS. However, these two cases demonstrate that prone ventilation can be an important addition in the management of intubated patients with CARDS, even in resource-limited settings like Ethiopia. We practice prone ventilation in all patients with COVID requiring respiratory support, from supplemental oxygen with nasal prongs to intubation and mechanical ventilation. Prone positioning, done both awake and sedated, was utilized for 12–18 h/day and was associated with a significant improvement in work of breathing, need for ventilator support, and gas exchange. As part of an aggressive supportive treatment approach, we believe that prone ventilation was partially responsible for the favorable outcomes in our patients.

We were fortunate to have experience in the use of prone ventilation before the beginning of the COVID-19 pandemic. We reported our first case, a patient with advanced ARDS at Tikur Anbessa Specialized Hospital (TASH) in Addis Ababa, at the American Thoracic Society International Conference in 2017.[5] Since then, it has become routine practice in our TASH ICU for selected patients.

Our use of prone ventilation in addition to low TV ventilation[6] in those with CARDS is in keeping with the recommendations of several international organizations and societies such as the World Health Organization, UK Intensive Care Society, and African CDC. These groups, extrapolating the physiologic benefits of the PROSEVA trial, have also been advocating the use of prone ventilation within 48 h for patients with severe CARDS (PaO_2/FiO_2 <150 mmHg).[7]

The ICU prone ventilation protocol in use at Eka Kotebe hospital in the management of CARDS patients is feasible and we believe easily implemented in other LMICs. Patients with unstable hemodynamics increased intracranial pressure, and recent abdominal surgeries were excluded from prone ventilation. What is required is a nurse-to-patient ratio of only 1:2, a ratio we believe is achievable in most ICUs in low resource countries. Good teamwork is important, but prone ventilation does not require special beds, expensive sedatives, or specific equipment. We use a team of five to seven healthcare workers, gathered around the bed, to reposition the patient; an advanced provider is responsible for securing the endotracheal tube during the maneuver. Adequate sedation and analgesia to Richmond Agitation Sedation Score of −2−−4 were utilized for patient comfort.

Although we reported only two cases here, in addition to provision of steroids, anticoagulation, and routine ICU care, we have been proning many intubated patients with CARDS and generally have seen favorable outcomes. Except for the occasional and small pressure ulcers over the face, we have not witnessed major complications associated with the procedure. This success has also encouraged the provider team to implement proning in awake and cooperative non-intubated patients in our hospital. Prone ventilation has now been adopted by the other COVID treatment centers in the nation.

CONCLUSION

Given the lack of effective treatment for COVID and the generally dismal outcome of intubated CARDS patients, treatment strategies that may have a survival advantage should be advocated. The successful treatment of these cases indicates that prone ventilation in intubated and non-intubated CARDS patients might still be beneficial and feasible in resource-limited settings.

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Declaration of patient consent

Patient’s consent not required as patients identity is not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

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