CASE REPORT

Dual Oxygen Therapy in COVID-19 Patient: A Method to Improve Oxygenation

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Abstract

Approximately 5–6% of patients diagnosed to have COVID-19 infection present with severe hypoxemia requiring invasive ventilation or non-invasive ventilation (NIV). Additional oxygen to patients on NIV can be given by nasal prong or by connecting oxygen tubing directly to the O_2 pick-off port of the NIV mask or by connecting oxygen tubing to the single-limb circuit in between ventilator and patient. Dual oxygen therapy improves oxygenation in COVID-19 patients on NIV. This method may make the patient more comfortable, increase tolerance to NIV, increase the usefulness of NIV for moderate and severe COVID-19 acute respiratory distress syndrome (ARDS).

Keywords: Acute hypoxemic respiratory failure (AHRF), COVID-19, Noninvasive ventilation.

Indian Journal of Critical Care Medicine (2021): 10.5005/jp-journals-10071-23725

Introduction

Approximately 5–6% of COVID-19 patients were present with severe hypoxemia. They require intensive care management with few requiring invasive or non-invasive ventilation.[1] The hypoxemia might not respond to high inspired oxygen fraction (FiO_2) using high-flow nasal cannula therapy (HFNC). The patients would eventually require escalation to continuous positive airway pressure (CPAP) or NIV. This is especially seen in cases of predominantly hypercapnic respiratory insufficiency (e.g., cardiac comorbidity, chronic obstructive airway disease (COPD), obesity hypoventilation, and neuromuscular disease).[2] Severe hypoxemia in such patients is attributed to high physiological dead space, as compared to previously published series of non-COVID-19 ARDS patients.[3] Liu et al. hypothesized an increase in alveolar dead space leading to a decrease in alveolar ventilation favoring hypercapnia.[3] During NIV, few patients are unable to maintain oxygen saturation despite being on 100% FiO_2 at high pressures. We propose the usage of dual oxygen therapy in which additional oxygen is delivered to the patient on NIV. This can be done by connecting nasal prongs or oxygen tubing directly to the O_2 pick-off port of the NIV mask or by connecting oxygen tubing to the single-limb circuit in between ventilator and patient. The dual oxygen therapy technique has already been described by Kumar et al.[4] This technique combines the principle of HFNC (by oxygen through a nasal cannula) and NIV ventilation (pressure support ventilation). Dual oxygen therapy may be more effective than using NIV or HFNC alone in COVID-19 patients presenting with respiratory distress. Here, we describe two cases of COVID-19 positive patients on NIV in which additional oxygen was supplemented by nasal cannula, using an extra oxygen flowmeter.

Case Reports

Case 1

A 64-year-old COVID-19 patient was presented with respiratory distress to our intensive care unit. High-resolution computed tomography revealed severe involvement of both the lungs. Supplemental oxygen was given at 15 L/min. The peripheral saturation of oxygen was 90% and arterial blood gas (ABG) analysis showed a pH 7.33, PCO_2 30.40, PO_2 73.8, Na 130, K 4.21, and HCO_3 17.9. Non-invasive ventilation (CPAP) was ensued with Fio_2 70%, pressure support 14, and positive end-expiratory pressure (PEEP) 7 (cm H_2O). Despite increasing the FiO_2 to 100%, the clinical status of the patient deteriorated the next day. He became tachypneic (respiratory rate (RR) > 35) with peripheral oxygen saturation of less than 90%. Extra oxygen through a nasal cannula at 10 L/min (Fig. 1) was added. This was done to decrease the rebreathing of expired air inside the NIV mask and in the anatomical dead space of the nasopharynx. Soon, we found improvement in oxygen saturation (SpO_2 > 95%) with ABG showing PO_2 85 mm Hg and PCO_2 37.

Case 2

A 70-year-old hypertensive and diabetic male patient was admitted to our ICU with respiratory distress following COVID-19 infection. Chest x-ray showed bilateral diffuse infiltrates. ABG on 15 L of oxygen by non-rebreathing mask showed severe hypoxia (Pao_2/Fio_2 < 100), and respiratory acidosis with pH 7.52, PO_2 56.3, PCO_2 31.5, SpO_2 <90. We gave non-invasive ventilation (CPAP) support with Fio_2 80%, pressure support 14, and PEEP 7 (cm H_2O). On the third day of CPAP therapy, the patient was unable to maintain oxygen

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How to cite this article: Kumar A, Kumar A, Sinha C, Kumar N, Singh K, Singh PK. Dual Oxygen Therapy in COVID-19 Patient: A Method to Improve Oxygenation. Indian J Crit Care Med 2021;25(2):231–233.

Source of support: Nil

Conflict of interest: None

Consent: Taken from the patient

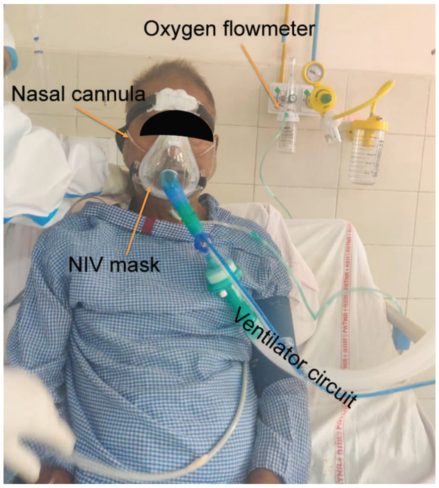

Fig. 1: Patient on NIV, with additional oxygen through the nasal cannula

saturation (SpO_2 < 92%) despite FiO_2 100% and became more tachypnic (RR > 40). There was increased respiratory distress and SpO_2 decreased to <90% despite FiO_2 100%. We gave supplemental oxygen by nasal cannula with O_2 flow 10 L by another flowmeter (Fig. 1). The patient became more comfortable, and SpO_2 increased to 95%. ABG showed PO_2 90 mm Hg, PCO_2 35, and SpO_2 97%. The patient recovered successfully from respiratory distress.

Discussion

The pathophysiology of the COVID-19 virus involves binding to the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) receptor (ACE2) which is strongly expressed in endothelial cells.[5] Infection of endothelial cells induces pulmonary endothelial lesions and triggers activation of coagulation, resulting in disseminated intravascular coagulation (DIC) like features. The initial therapy of hypoxemia and respiratory failure focuses on oxygen administration via nasal tube, venturi mask, and HFNC. Once the gas exchange deteriorates progressively and oxygen demand increases, a need for CPAP or ventilation should be considered. Earlier studies show >50% therapy failure on using NIV in moderate and severe COVID-19 ARDS.[2] The main reason for oxygenation failure in NIV is because the interface for NIV and ventilator circuit provides additional dead space. Hence, the chances of CO_2 rebreathing increase.[6,7] Schettino et al.[6] evaluated the effects of mask volume in rebreathing during CPAP ventilation. They reported that the volume of the mask was associated with CO_2 rebreathing. The ineffective seal of the airway passage leads to leakage of air and loss of the positive airway pressure effect which in turn might cause the failure of HFNC in COVID-19 ARDS. Furthermore, in HFNC the mitigation of air leaks requires breathing from the nose with the mouth closed.

In our patients, there was an improvement in SpO_2, which might be due to increased oxygen concentration inside the mask by using dual oxygen therapy. The mechanisms of action could be (1) washout of anatomic dead space due to additional oxygen, (2) improved gas mixing in large airways, (3) increase in oxygen concentration inside the NIV interface, and (4) decrease in mask volume rebreathing. Unlike masks, helmets behave like a semi-closed environment in which the chance of CO_2 rebreathing is high because its internal gas volume is larger than the tidal volume.[8] However, by using dual oxygen therapy, the chances of rebreathing are decreased with improvement in oxygenation. It might in turn make the patient more comfortable and prevent intubation and its complications.

Spontaneously breathing patients with acute hypoxemic respiratory failure (AHRF) exhibit high respiratory drive with high breathing volumes, and thus a potentially damaging transpulmonary pressure variation.[9] High tidal volumes (>9.2 or 9.5 mL/kg) under NIV are associated with increased mortality in COVID-19.[9,10] The technique of dual oxygen therapy might decrease the hypoxic respiratory drive in spontaneously breathing patients and might also decrease the pressure support in the context of NIV.

Conclusion

We suggest that dual oxygen therapy might be used in COVID-19 hypoxemic patients as it improves oxygenation. Our conclusion is based on two patients, hence further well-conducted randomized controlled trials might be required to substantiate our findings.

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References

1. Yang X, Yu Y, Xu J, Shu H, Xia J, Liu H, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. Lancet Respir Med 2020;8(5):475–481. DOI: 10.1016/S2213-2600(20)30079-5.
2. Rochwerg B, Brochard L, Elliott MW, Hess D, Hill NS, Nava S, et al. Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure. Eur Respir J 2017;50(2):1602426. DOI: 10.1183/13993003.02426-2016.
3. Liu X, Liu X, Xu Y, Xu Z, Huang Y, Chen S, et al. Ventilatory ratio in hypercapnic mechanically ventilated patients with COVID-19 associated ARDS. Am J Respir Crit Care Med 2020;201(10):1297–1299. DOI: 10.1164/rccm.202002-0373LE.
4. Kumar A, Kumar L, Sinha C, Kumar N, Bhadani UK. Dual oxygen therapy in patient on bilevel positive airway pressure prevented invasive mechanical ventilation. Indian J Crit Care Med 2017;21(9):604–606. DOI: 10.4103/ijccm.IJCCM_199_17.
5. Wan Y, Shang J, Graham R, Baric RS, Li F. Receptor recognition by the novel coronavirus from Wuhan: an analysis based on decade-long structural studies of SARS coronavirus. J Virol 2020 2020;94(7):e00127-20. DOI: 10.1128/JVI.00127-20.
6. Schettino GP, Chatmongkolchart S, Hess DR, Kacmarek R. Position of exalation port and mask design affect CO2 rebreathing during non-invasive positive pressure ventilation. Crit Care Med 2003;31(8):2178–2182. DOI: 10.1097/01.CCM.0000081309.71887.E9.

7. Gonzalez J, Sharshar T, Hart N, Chadda K, Raphae l JC, Lofaso F. Air leaks during mechanical ventilation as a cause of persistent hypercapnia in neuromuscular disorders. Intensive Care Med 2003;29:596–602. DOI: 10.1007/s00134-003-1659-5.
8. Taccone P, Hess D, Caironi P, Bigatello LM. Continuous positive airway pressure delivered with a "helmet": effects on carbon dioxide rebreathing. Crit Care Med 2004;32(10):2090–2096. DOI: 10.1097/01.ccm.0000142577.63316.c0.
9. Gattinoni L, Coppola S, Cressoni M, Busana M, Rossi S, Chiumello D. COVID-19 does not lead to a "typical" acute respiratory distress syndrome. Am J Respir Crit Care Med 2020;201(10):1299–1300. DOI: 10.1164/rccm.202003-0817LE.
10. Frat JP, Ragot S, Coudroy R, Constantin JM, Girault C, Prat G, et al. Predictors of intubation in patients with acute hypoxemic respiratory failure treated with a noninvasive oxygenation strategy. Crit Care Med 2018;46(2):208–215. DOI: 10.1097/CCM.0000000000002818.