

High Flow Nasal Cannula and Non-Rebreather Mask – An Approach to Avoid Tracheal Intubation in COVID-19 Patients to Maintain Normal Oxygen Saturation – A Case Series

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Abstract:

Recently caused pandemic by newly discovered corona virus (COVID-19) has affected millions of people all over the world. Most people infected develop mild to moderate illness and recover without serious implications while few may develop serious pulmonary exhibitions like pneumonia and acute respiratory distress syndrome. These pulmonary findings may cause decrease in oxygen saturation where tracheal intubation becomes fundamental and life saving. In this case series, we present four COVID-19 patients where intubation was avoided by using high flow nasal cannula and non-rebreather mask together to maintain the oxygen saturation in a COVID-19 intensive care unit.

Keywords: COVID-19, Pneumonia, Acute respiratory distress syndrome, High flow nasal cannula, non-rebreather mask.

Introduction:

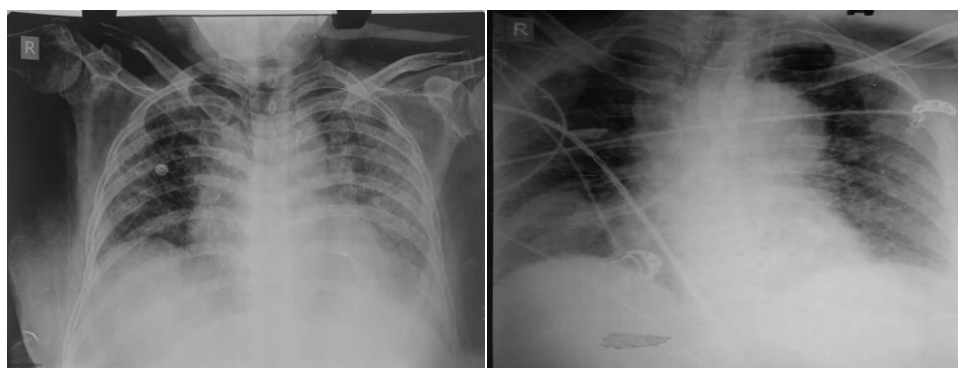
Beginning in December 2019, a newly discovered strain of corona virus named as severe acute respiratory distress syndrome coronavirus 2 (SARS-CoV-2) which has spread worldwide causing a pandemic situation and affected millions of people till date.¹ The most commonly COVID-19 affected system in human body is pulmonary system with mild symptoms like cough, fever and sore throat. In severe cases the patient's clinical course from mild symptoms is convoluted by the development of pneumonia, acute respiratory distress syndrome, respiratory failure and death. As the pulmonary system is most commonly affected by COVID-19, other organs and organ systems (including the cardiac, gastrointestinal, hepatic, renal, ocular, and dermatologic) can also be affected, which can cause marked health effects.² When the pulmonary involvement is lot maintenance of oxygen saturation becomes a difficulty in those patients.

The intensivist has to play a pivotal role in making the decision to attain what measures for maintaining the oxygen saturation of the patient. Oxygen therapy and respiratory support becomes important in COVID-19 generated ARDS.³ In COVID-19 positive patients with respiratory failure by whatever way of delivering oxygen it is important to maintain oxygen saturation above 90% for the normal functioning of the body.

In our case series we present four cases of COVID-19 patients with respiratory failure where we have used high flow nasal cannula and non-rebreather mask combination to maintain oxygen saturation above 90% and we are able to defer intubation in these patients.

CASE PRESENTATIONS:**CASE 1**

A 65 years old female with history of hypothyroidism on medication presented with fever, cough and difficulty in breathing. She was diagnosed COVID-19 positive by reverse transcriptase polymerase chain reaction (RT-PCR) on the day of admission and shifted to COVID ICU. On admission the patient was afebrile (97.7°F) with a pulse of 88/min, blood pressure of 126/88mmHg and oxygen saturation of 61% on room air. The oxygen saturation was corrected to 72% with face mask and to 89% with reservoir bag. Then the patient was connected to 60 L high flow nasal cannula and 15 L non-rebreather mask after which the oxygen saturation was corrected to 98%. The initial investigations like complete blood count, kidney function test, liver function test didn't reveal any abnormality. Arterial blood gas analysis after admission with 15L O₂ via NRBM was a pH of 7.422, pCO₂ of 37.2, pO₂ of 57.1 giving a PaO₂/FiO₂ ratio of 63.44, falling to classification of severe ARDS by Berlin criteria⁴. Chest xray revealed bilateral pulmonary infiltrates. In the first 24 hours the oxygen requirement to maintain spO₂ above 90% kept on increasing without increasing her respiratory effort. Over the course of her ICU stay she was continued with HFNC plus NRBM which helped her to maintain spO₂ above 90% and prevented her from getting intubated. She received injection remdesivir, injection azithromycin, injection piperacillin tazobactam, tablet ivermectin and supportive treatment during her ICU stay. During her stay at hospital there was no gross abnormality in her renal, liver or hematologic laboratory tests. By 10th day of her ICU stay her ABG picture improved and HFNC was removed and she was able to maintain spO₂ above 90% with NRBM only O₂ @ 8-10L/min. On the 12th day she was weaned of NRBM and required only occasional oxygen through nasal cannula with flow rate of 3L/min. On the 14th day she was discharged from ICU as the patient didn't require any support further.



Chest Xray of patient after admission

Chest Xray of the patient before discharge

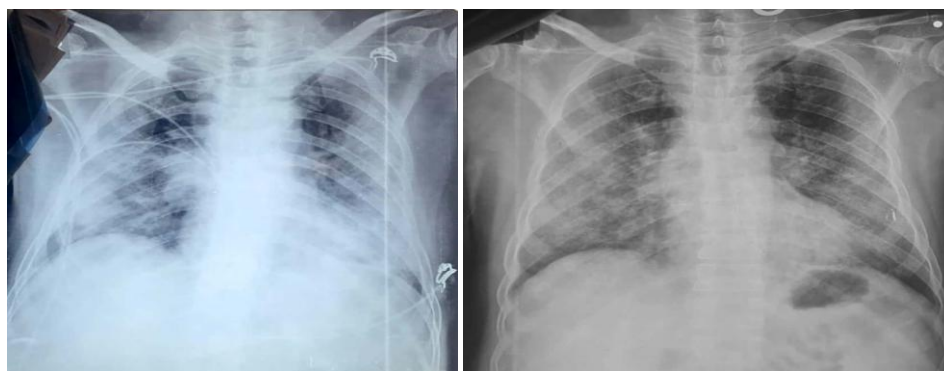
ABG of the patient:

Case1					
	admission	day 3	day 7	Day 10	Discharge
pH	7.422	7.414	7.388	7.421	7.386
pCO ₂	37.2	43.5	48.7	40.2	41.3
pO ₂	57.1	69.6	77.9	78.6	66.4
		60LHFNC+15LNRBM	40LHFNC+15LNRBM	10LNRBM	ROOM AIR

CASE 2

A 64 years old male with history of hypertension on medication for the last 10 years and a known case of benign prostate hyperplasia presented with fever, hemoptysis, burning micturition and loss of appetite for the last 4 days. On admission the patient was conscious oriented with pulse of 92/min, blood pressure of 102/60mmHg, spO₂- 80% on room air. He was diagnosed COVID-19 positive by reverse transcriptase polymerase chain reaction (RT-PCR) on

the day of admission and shifted to COVID ICU. Immediately the patient was connected to NRBM with oxygen flow of 15L and his spO_2 improved to 84%. In order to avoid intubation the patient was connected to HFNC with oxygen flow of 60L and NRBM of 15L. Chest Xray showed bilateral diffuse infiltrates. The patient also developed deep venous thrombosis lower leg right side and CT angiography revealed pulmonary thromboembolism and multifocal peripheral areas of ground glass opacities with septal thickening and fibrotic bands in bilateral lung fields. Patient was put on warfarin therapy to maintain INR between 2-3 and DVT pump was applied. The patient was initiated on awake proning protocol, which consisted of lying in prone position for at least 12 hours per day.⁵ The oxygen requirement gradually decreased over a period of time. By 7th day he was on 40L HFNC and 15L NRBM with an improved ABG picture. During his stay in ICU he received injection remdesivir, inj meropenem, inj heparin, tablet warfarin with a close monitoring of INR to maintain between 2-3. His investigation were almost within normal limits with slight decrease in urine for 3-4 days which was tackled by injectable frusemide. On the 15th day he was weaned off HFNC and only required NRBM @ 8L to maintain spO_2 above 90%. By 18th day of his ICU stay he was able to maintain spO_2 above 90% and was shifted out of ICU with normal ABG.



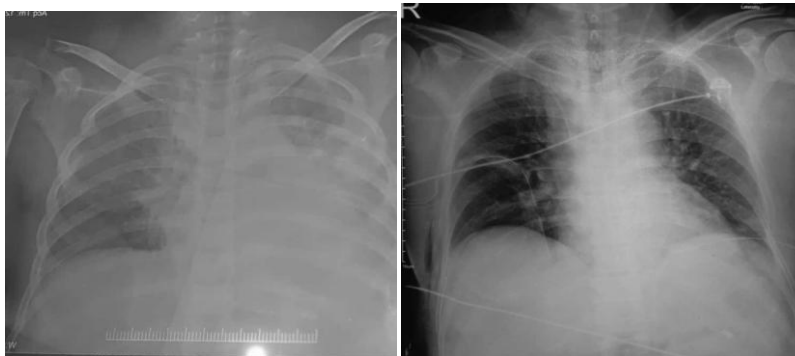
Chest Xray of patient after admission Chest Xray of the patient on 16th day

ABG of the patient:

CASE 2						
	admission	Day 3	Day 7	Day 10	Day 15	Discharge
pH	7.357	7.366	7.402	7.456	7.360	7.468
pCO ₂	55.7	49.2	41.6	41.5	38.9	45.6
pO ₂	52.6	63.1	76.8	90.8	88.7	68.0
		60LHFNC+15LNRBM	40LHFNC+15LNRBM	35LHFNC+10LNRBM	8LNRBM	ROOM AIR

CASE 3

A 45 years old male patient with history of type 2 diabetes on oral hypoglycemic agent for the last 1 year presented with fever and cough for the last 3 days. On admission the patient was conscious oriented diagnosed COVID-19 positive with pulse of 72/min, blood pressure 110/70 mmHg and spO_2 of 92% on NRBM @ 12L, FBS-138(pH-7.442, pCO₂-40.5, pO₂-64.8). On the 3rd day of admission the patient was dyspneic and not maintaining spO_2 > 90% on NRBM for which he was shifted to ICU. The patient was put on HFNC 60L plus NRBM 15L and his spO_2 started improving. Chest Xray showed bilateral lung infiltrates. During his course of treatment patient had developed septic shock and received Noradrenaline infusion at low dose to maintain MAP above 60mmHg⁶ which was gradually tapered off. He was treated with tab tamiflu, inj meropenem, inj caspofungin, infusion insulin to maintain his blood glucose level <180mg/dl⁷, awake prone position for 10-12 hours per day, incentive spirometry. The oxygen requirement gradually started decreasing and by 20th day the patient was able to maintain spO_2 >90% without oxygen supply.



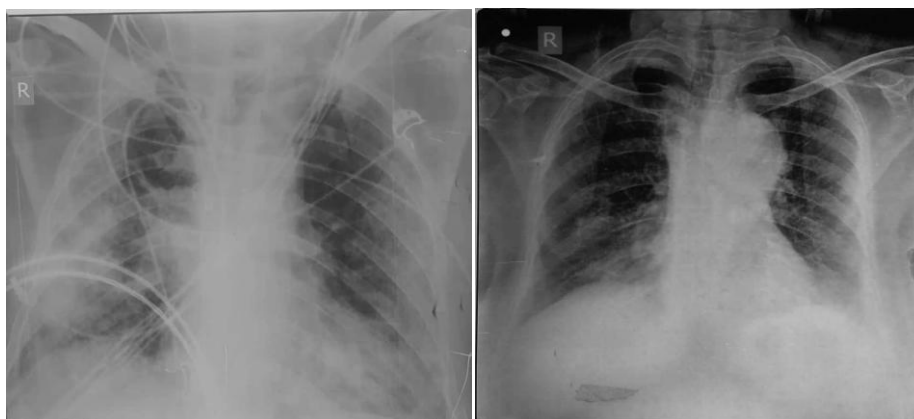
Chest Xray of patient after admission

Chest Xray of the patient on 19th day**ABG of the patient:**

CASE 3							
	admission	3 rd day	7 th day	10 th day	15 th day	18 th day	Discharge
pH	7.442	7.443	7.484	7.474	7.5	7.450	7.386
pCO ₂	40.5	33.2	39.9	31.7	30.9	43.1	42.5
pO ₂	64.8	52.7	112.4	98.6	115	81.7	72.2
		HFNC 60L+NRBM 15L started	HFNC 40L+NRBM15L	HFNC35L+ NRBM10L	HFNC 30L+NRBM 10L	NRBM 10L	ROOM AIR

CASE 4

A 53 years old overweight female patient (BMI-28)⁸ with no co morbidity presented with fever, cough and shortness of breath for last 2 days. On admission the patient was conscious oriented diagnosed COVID-19 positive with pulse of 102/min, blood pressure 143/86mmHg, and spO₂ of 86% with NRBM 15 L (pH-7.380,pCO₂-48.6,pO₂-58.9). The patient was shifted to ICU and connected to HFNC 60L and NRBM 15L in order to avoid intubation. Chest Xray finding showed bilateral peripheral ground glass haze. During the course of hospital stay she received injection remdesivir, injection azithromycin, tablet ivermectin and supportive treatment like awake prone positioning, incentive spirometry. During her stay at hospital there was no gross abnormality in her renal, liver or hematologic laboratory tests. The oxygen requirement gradually started decreasing and by 14th day she was able to maintain spO₂ above 90% on room air and got discharged.

Chest Xray of patient after admission Chest Xray of the patient on 13th day

ABG of the patient:

CASE 4						
	admission	3 rd day	7 th day	10 th day	12 th day	Discharge
pH	7.380	7.411	7.400	7.396	7.456	7.388
pCO ₂	48.6	46.7	41.4	44.1	45.2	42.4
pO ₂	58.9	111.6	99.4	112.6	97.8	78.5
		HFNC 60L+NRBM 15L	HFNC 40L+NRBM 15L	HFNC 30L+NRBM 10L	NRBM 10L	ROOM AIR

DISCUSSION:

In this case series we have discussed about the results of respiratory management of four COVID-19 positive with high flow nasal cannula and non-rebreather mask combined. The patients were admitted with complaints of fever and breathing difficulty, diagnosed COVID-19 positive and initial chest Xray showed bilateral lung infiltrates. The patients were given HFNC plus NRBM and the oxygen saturation started improving for which the need of intubation was deferred in all the four patients. Later all the patients improved and were discharged without any oxygen supplementation.

The high flow nasal cannula used in our institute is an oxygen supply device which can deliver 100% humidified oxygen at a flow rate of 60 litres per minute. A non-rebreather mask is a device which assist in delivery of oxygen and can deliver up to 70% oxygen with high flow oxygen. In our cases the patients were kept in awake prone position for 10-12 hours per day along with HFNC plus NRBM. Awake prone positioning showed marked improvement in P/f ratio and SpO₂ in COVID-19 patients with improvement in clinical symptoms with reduced rate of intubation.⁵ In prone position, there is homogeneous distribution of the gas which reduces the ventilation-perfusion (V/Q) mismatch which ultimately reduces the intrapulmonary shunt and opens the atelectatic lung areas with adequate sputum drainage, improving oxygenation.

Geng S et al⁹ stated in their study regarding use of HFNC in COVID-19 patients that HFNC provides a specific positive end expiratory pressure which has a tremendous effect on patients with mild to moderate type 1 respiratory failure, providing humidified gas reducing metabolic work of gas conditioning and most importantly it reduces the need of intubation thus increasing the prognosis of patients with acute respiratory failure. Roy et al¹⁰ stated that NRBM can be used to provide moderate to high FiO₂ for moderate duration and with a tight-fitting mask, the aerosol spread is minimum.

On February 11 2020 WHO declared a new virus COVID-19, which is the acronym of "coronavirus disease 2019 outbreak causing low respiratory tract infections which is very contagious and has quickly spread globally.¹¹ The symptoms vary from mild disease to severe to critical illness. It can lead to acute respiratory distress syndrome (mild, moderate, severe) to extrapulmonary manifestations like kidney damage and sepsis. So the treatment modality of COVID-19 positive patients vary from mild supportive therapy to treatment of severe manifestations and some may require intubation and mechanical ventilation. However once the patient is intubated it becomes very difficult to wean the patient and to prevent intubation related morbidities. In our case series we were able to defer intubation to maintain normal oxygen saturation by using the combination of high flow nasal cannula and non rebreather mask.

To our knowledge as we have seen through our case series combination of high flow nasal cannula and non-rebreather mask can be a rescue tool for the intensivist which can defer the need of intubation thus providing a better prognosis for some selected patients. More studies are required in this field to assure this technique as a better tool having a positive impact in the outcome of COVID-19 patients.

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