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Awake self-proning for COVID-19 non-intubated patients—a single-centered experience

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Abstract

Background COVID-19 patients with respiratory failure may need intensive care unit (ICU) admission. Prone positioning in mechanically ventilated patients improves oxygenation and reduces mortality in moderate to severe acute respiratory distress syndrome. For better oxygenation and outcomes, awake proning is being tried in non-intubated patients also. Our aim was to investigate advantage of awake self-prone positioning with oxygen therapy using non-rebreathing mask (NRBM) in COVID-19 ICU patients.

Results This prospective observational study was conducted in ICU from 18th November 2020 to 28th February 2021. Sixty COVID-19 cooperative patients with hypoxemia on arrival with hemodynamic stability were included. Patients on NRBM were advised to turn prone for 12–14 h per day. Oxygen saturation (SpO_2) was recorded in supine position and 30 min after initiation of prone positioning. Ratio of arterial partial pressure of oxygen and fractional concentration of inspired oxygen (P/F) was recorded in supine and 24 h after initiation of prone position. Primary outcome was improvement in $SpO_2 > 94\%$. Secondary outcome was incidence of intubation.

Sixty patients were received in ICU with supplemental oxygen, and median SpO_2 was 80% (*IQR* 70–88%). Patients were put on NRBM with median SpO_2 in supine position 86% (*IQR* 76–90). Thirty minutes of proning increased SpO_2 to 94% (*IQR* 89 to 97%). Wilcoxon rank-sum test was used ($P = 0.001$). Forty-three patients did not require intubation, and seventeen patients needed intubation.

Conclusions Awake self-proning in COVID-19 patients on NRBM improved oxygenation with reduced intubation rate.

Keywords Awake, Coronavirus, Hypoxemia, Non-rebreathing mask, Proning

Background

The novel coronavirus disease 2019 (COVID-19) causes pneumonia and subsequently progresses from hypoxemic respiratory failure to classic acute respiratory distress syndrome (ARDS) requiring mechanical ventilation (Hui et al. 2020).

Presentation of COVID-19 patients is often with low oxygen saturation ($SpO_2 < 90\%$) without much breathing difficulty and tachycardia and is referred as happy hypoxia (Wilkerson et al. 2020). But there is always need for supplemental oxygen in these patients. Awake self-proning has emerged as a beneficial therapeutic option resulting in better oxygenation with avoidance for intubation and invasive ventilation (Caputo et al. 2020; Coppo et al. 2020; Bower et al. 2020). The mechanism for improved oxygenation is reduction in ventilation/perfusion (V/Q) mismatch and more uniformity of lung perfusion in prone position (Sztajnbok et al. 2020). We aimed

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to describe feasibility as well as potential benefits of early and awake self-proning for non-intubated patients suffering from COVID-19 pneumonia.

Objectives

The primary objective was improvement in SpO_2 approximately 30 min after initial proning without changing inspired concentration of oxygen. The secondary objective was rate of intubation in patients with failed proning.

Methods

This is a single-centered, prospective, observational study of a convenient sample of 60 COVID-19 patients admitted at intensive care unit (ICU) between 18th November 2020 to 28th February 2021. Written informed or witnessed verbal informed consent was obtained. Study was approved by institutional ethical committee (Gujarat Cancer and Research Institute, Ahmedabad, dated 19 March 2021, reference number IRC/2021/P-15). Patients were adults, diagnosed with COVID-19 by RT-PCR (real-time polymerase chain reaction) technique, conscious, cooperative, $SpO_2 < 88\%$ on ICU admission, hemodynamically stable, able to achieve self proning, and on nonrebreathing mask (NRBM) for oxygenation.

Exclusive criteria were patients receiving noninvasive ventilation (NIV) or intubated, drowsy, uncooperative, and hemodynamically unstable. Baseline demographic and clinical characteristics were noted. Vital signs monitored were SpO_2, electrocardiogram (ECG), temperature, blood pressure, and respiratory rate. SpO_2 was measured using standard pulse oximeter. A base line arterial blood gas (ABG) measurement was done and repeated after 24 h of initiation of proning. $SpO_2 < 88\%$ was considered as hypoxemia. The primary objective was improvement in SpO_2 approximately 30 min after initial proning without changing inspired concentration of oxygen. The secondary objective was rate of intubation in patients with failed proning. Failed proning was determined when $SpO_2 < 88\%$ with increase in respiratory rate, altered level of consciousness, hypotension, and shock were noticed. These patients were immediately intubated and put on mechanical ventilation.

Patients selected were those presented to ICU with supplemental oxygen with face mask at 5 l/min and NRBM at 8–10 l/min. As target $SpO_2 > 94\%$ was not achieved, they were considered for oxygen supplementation through NRBM 12–15 l/min. Each patient was explained about awake self-prone position. They were encouraged to remain in prone position for maximum possible time as they could tolerate with a target time of prone position of 12–14 h/day. To tolerate prone positioning, alternate lateral and prone position were encouraged to achieve a target of 12–14 h of proning time. All patients received COVID-19-specific treatment as per the institutional policy.

Patients were discharged from ICU to ward when SpO_2 is > 95% with clinical improvement at least for the last 24 h in any position.

Statistical analysis

Data was analyzed using descriptive method. Median SpO_2 was determined before and after proning. As it was not normally distributed, comparison of SpO_2 median value was done using the Wilcoxon rank-sum test. Rate of intubation was determined using proportion. Mean ± SD was used for P/F ratio (arterial partial pressure of oxygen and fractional concentration of oxygen in inspired air) which was analyzed using students, *t*-test. Analysis was done using SPSS software (Version 20, TBM Corp., USA) with consideration of P-value < 0.05 as statistically significant.

Results

Sixty patients were enrolled in our study between 18th November, 2020, to 28th February, 2021, period. The characteristics of study population are mentioned in Table 1.

Convenient sample cohort was included in this study. Most of patient had respiratory complaints while presenting to ICU. The median age of population was 56 (*IQR* 51 to 67) and body mass index (BMI) 26.3 kg/m^2 (*IQR* 22.6 to 29.3 kg/m^2). Forty-nine patients were male. All patients were on oxygen supplementation through face mask or nonbreathing mask on arrival to ICU. Patients on presentation to ICU on face mask and NRBM (8–10 l/min) were not maintaining SpO2 > 88% and were put on NRBM (12–15 l/min) and included in study population.

Forty-three patients showed improvement without intubation and discharged to ward. Clinical condition of 17 patients deteriorated within 48 h of ICU admission requiring endotracheal intubation and mechanical ventilation. Six patients needed intubation within 1 h of proning, seven after 1 h, but within 24 h of proning,

Table 1 Demographic and clinical characteristics of patients

Variable	Population (N-60)
Age (years)	56 (51–67)
Male/female	49/11
BMI (kg/m^2)	26.3 (22.6–29.3)
Oxygen by NRBM	60 (100%)
No need of intubation	43 (71.66%)
Endotracheal intubation needed	17 (28.33%)

Data presented as number (%), median & interquartile range

and four patients between 24 and 48 h were subsequently intubated.

As shown in Table 2, all patients of study were provided oxygen through NRBM at a rate of 12–15 l/min in ICU.

Median SpO_2 with NRBM in supine position was 86% (*IQR* 76–90). After addition of 30 min of proning, median SpO_2 value improved to 94% (*IQR* 89 to 97). Comparison of SpO_2 in supine and after proning was done by using Wilcoxon rank-sum test with a statistically significant *P*-value 0.001. P/F ratio was improved by baseline mean value of 90.7 ± 25.8 mm of Hg to 132.7 ± 42.6 after 24 h of initiation of proning. This improvement in P/F ratio was also statistically significant with a *P*-value of less than 0.0001. Further, ABG analysis was not done in patients who were maintaining $SpO_2 > 90\%$ on NRBM in prone position.

Discussion

The characteristic of early COVID-19 pneumonia is the absence of marked dyspnea despite of being severely hypoxemic (Wilkerson et al. 2020). As the disease progresses, oxygen requirement also increases. Different modalities like high-flow oxygen therapy or noninvasive positive pressure ventilation (NIPPV) are useful to fulfill the requirement. Major drawbacks associated with these therapies are aerosolization of viral particles. Patients with ARDS may need intubation and mechanical ventilation (Tobin et al. 2020). Thereafter, the choice of oxygenation technique which reduces lung injury is paramount to reduce the mortality.

In initial phase of COVID pandemic, very little pathophysiology of COVID-19 was known. Hence, these patients were intubated early to reduce work of breathing and to prevent lung injury. But high mortality was detected with this approach in later part (Hui et al. 2020). It also resulted in crisis of manpower and other resources also.

Prone positioning has been found to provide better oxygenation with recruitment of the lung in ARDS patients during invasive ventilation (Gattinoni et al. 2019). Uniform alveolar perfusion results in improvement in V/Q mismatch with improving oxygenation and hence reduction in mortality also.

Benefit of prone positioning in awake, non-intubated patients with COVID-19 has been described in various case reports and case series also (Koeckerling et al. 2020; Singh et al. 2020; Jena et al. 2020; Giron et al. 2020). In a case series of fifty COVID patients, SpO_2 improved from 84% with supplemental oxygen to 94% after proning of 5 min, and only 13 patients needed intubation (Caputo et al. 2020). In another case series of 15 patients, awake self-proning was encouraged for a period of 10–12 h/day in non-intubated COVID-19 patients. There was improvement in SpO_2 and P/F ratio. They described need of invasive ventilation in two patients only (Singh et al. 2020). In a study done by Sartini and colleagues, proning was advocated for patients on continuous positive airway pressure (CPAP), and marked improvement in oxygenation was found by them (Sartini et al. 2020). Elharrar and colleagues observed improved oxygenation after proning in 25% of study population only (Elharrar et al. 2020).

Before COVID-19, limited literature was available stating benefits of awake proning in non-intubated patients (Ding et al. 2020).

When increasing number of patients required respiratory support for ARDS during COVID pandemic, awake proning was discovered as an innovative approach limiting the requirement for endotracheal intubation and invasive ventilation.

In our study, protocol for proning included proning period as much as patient could tolerate. Alternate right or left lateral position, whichever improve breathing and comfort, according to patient's wish, was recommended. Target duration of proning was 12–14 h/day. In a study, significant benefit of suitable lateral or prone position is described in spontaneously breathing non-intubated COVID-19 patients (Schifino et al. 2021).

Most patients (71%) in our study did not require intubation. These patients on NRBM showed improvement in symptoms with prone positioning without any adverse event like neuropraxia or pressure ulcers and tolerated well, and improvement in P/F ratio allowed to decrease the oxygen requirement. No significant difference was observed in $PaCO_2$ which was measured in supine and 24 h after proning.

They were discharged from ICU to ward when clinical improvement was seen, and they were able to maintain $SpO_2 > 94\%$ for the last 24 h in any position which patient felt comfortable. Average ICU stay was 5 days.

Table 2 Improvement in SpO_2 and P/F ratio

Variable	Supine	Prone	*p*-value
SpO_2 (%)	86 (76–90)	94 (89–97) (approximately 30 min after initiation of proning)	0.001
P/F ratio (mm of Hg)	90.7 ± 25.8	132.7 ± 42.6 (24 h after initiation of proning)	< 0.0001

Data presented as median, interquartile range, mean ± standard deviation

There was need of intubation and invasive ventilation in 17 patients starting from 1 to 48 h of initiation of proning due to either intolerance to proning or clinical deterioration even with proning. These patients had comorbidities like hypertension, diabetes, hypothyroidism, and malignancy. Seven patients were above 60 years of age. Intolerance to proning was because of coughing, discomfort, or uncooperativeness despite of explanation of benefits of proning.

Our experience recommends awake self-proning technique as an important tool, particularly for overburdened health system, for improvement of oxygenation and clinical condition in most of the patients with moderate to severe COVID-19. Proper placement of pillows or blankets may be of benefit in some patients during proning. Patients who are managed with these oxygen support therapies need continuous monitoring with proper and frequent reassessment.

To our knowledge, we conducted largest prospective trial to evaluate potential benefit of prone position in awake, non-intubated COVID-19 patients with pneumonia.

Limitations

Convenience sampling is done from single institute and so may not be representative of other population. This is a nonexperimental study with no randomization and no control group. All treatment options are not controlled, so the effect seen may be because of some unrecognized alternative treatment also. Correlation is between the day of illness, while ICU admission and outcome need to be investigated. High-flow nasal cannula was not used in our institute due to oxygen constraints.

Finally, further prospective, randomized, and controlled studies are required to determine causality and benefit of this strategy.

Conclusions

Awake proning in non-intubated COVID-19 patients is feasible and low cost and easy to implement approach resulting in marked improvement in oxygenation without major adverse effect. Early and frequent use of proning reduces intubation rates as well.

Abbreviations

ARDS	Acute respiratory distress syndrome
V/Q	Ventilation/perfusion
N	Number
BMI	Body mass index
NRBM	Non-rebreathing mask
NIPPV	Noninvasive positive pressure ventilation
ICU	Intensive care unit
IQR	Interquartile range
ABG	Arterial blood gas
CPAP	Continuous positive airway pressure
SpO_2	Peripheral oxygen saturation of hemoglobin
P/F ratio	Arterial partial pressure of oxygen and fractional concentration of oxygen in inspired air

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Authors' contributions

RNS conceived of the study, wrote and drafted the manuscript, revised the final manuscript, and provided tables; JMT conceived of the study, contributed to the manuscript, and contributed tables; and all authors have read and approved the manuscript.

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Availability of data and materials

The data used/analyzed during this study are available from corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

After obtaining local ethical committee approval (Gujarat Cancer and Research Institute, Ahmedabad, dated 19 March 2021, reference number IRC/2021/P-15), written and informed consent was obtained from patients/relative.

Consent for publication

Written informed consent was taken from all the patients.

Competing interests

The authors declare that they have no competing interests.

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