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Original Article
DOI:

EFFECT OF PRONE POSITIONING WITH HFNO IN MODERATE TO SEVERE ARDS

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ABSTRACT

INTRODUCTION: The WHO, broadcasted COVID 19 as a public health emergency on JANUARY 30th ,2020 and subsequently declared a pandemic on MARCH 11th 2020.Acute respiratory distress syndrome (ARDS) is a major complication of COVID-19 that occurs in 20-41% of patients with severe disease.The pathophysiology of ARDS and COVID-19 lung injury share many of the same aspects of reduced lung parenchymal compliance, vasculopathy, alveolar flooding, and gas exchange impairment arising from direct infectious causes and noninfectious injuries.In patients with pneumonia,HFNO allows improved mobilisation of secretions,minimises oxygen dilution,meets inspiratory demands and improve end-expiratory lung volumes.According to the present theories, prone positioning, by reducing ventral alveolar expansion and dorsal alveolar collapse, results in ventilation that is more homogeneous.

OBJECTIVE: The goal of our study is to evaluate the reduction in consumption of oxygen by using proning as an adjunct to HFNO in patients of COVID 19 admitted in ICU.

METHOD: This is an observational cross sectional type of study, which includes patients who were hemodynamically stable and required HFNO to maintain oxygenation. All patients were counselled for the benefits of proning. Proning was done with the help of nursing staff. All vitals were noted before proning and all throughout proning. We kept patients in a prone position till patients were comfortable and duration of proning was noted. We titrated oxygen requirement (FIO2 and flow) to target spo2 level of 93-95%.

RESULT: We studied in 26 patients on HFNO with proning, we found that proning helps in 11-50% reduction in oxygen requirement to achieve target Spo2 level.The mean value of oxygen consumption was 20833.27 L/HR with only use of HFNO which was more than 15996.92 L/HR when patients were encouraged to be prone along with the use of HFNO.The collected data was analysed and unpaired t test was applied after which p value of 0.0154 was obtained, which is statistically significant.

CONCLUSION: Based on this study it is concluded that there is significant reduction in consumption of oxygen by using the prone position as an adjunct to HFNO in patients of COVID 19.

KEY WORDS: COVID-19, ARDS, HFNO, Prone position

INTRODUCTION:

The WHO, broadcasted COVID 19 as a public health emergency on JANUARY 30th ,2020 and subsequently declared a pandemic on MARCH 11th 2020 (10).The pandemic originated in DECEMBER 2019, as SARS-CoV-2 caused a series of acute atypical respiratory diseases in Wuhan,Hubei province,China. The virus is transmissible between humans via air droplets.(3)

Acute respiratory distress syndrome (ARDS) is a major complication of COVID-19 that occurs in 20-41% of patients with severe disease.(4) ARDS is a complex syndrome of acute lung injury leading to noncardiogenic pulmonary edema from many causes that is heterogeneous in its clinical presentation and associated with a 40% mortality rate.The pathophysiology of ARDS and COVID-19 lung injury share many of the same aspects of reduced lung parenchymal compliance, vasculopathy, alveolar flooding, and gas exchange impairment arising from direct infectious causes and noninfectious injuries. Exuberant host defence inflammatory responses lead to endothelial and epithelial cell damage and loss of the normally tight alveolar–capillary barrier and its ability to maintain a dry alveolar space for efficient gas exchange.(5)

High flow nasal oxygenation uses heated and humidified oxygen in treatment of respiratory failure for patients of COVID 19.It heats up the gas, while delivering 0.21-1.00% fraction of inspired oxygen (FIO2) at up to 100 litres flow rate per minute with a 100% relative humidity. The flow rate and FIO2 can be both titrated according to the patients requirements.

In patients affected with pneumonia, HFNO allows improved mobilisation of secretions,meets inspiratory demands, minimises dilution of oxygen and improve end-expiratory lung volumes; which are the probable mechanisms benefiting the patients by the use of HFNO. (6)

The physiological aims of prone position can be summarised as:

1) Oxygenation is improved;
2) Improvement in respiratory mechanics;
3) Homogenisation of the pleural pressure gradient, alveolar inflation and ventilation distribution;
4) Increasing lung volume and reduction of atelectatic regions;
5) Facilitating secretion drainage; and
6) Reduction in ventilator-associated lung injury.(7)

In supine position, the central posterior parts of the lung are likely compressed by the heart and its adjacent structures, whereas in prone position, the central anterior parts get compressed; which leads to increasing cardiac output and improving pulmonary respiration and are among the advantages of prone positioning(8).

According to the present theories, prone positioning, reduces ventral alveolar expansion and dorsal alveolar collapse, resulting in homogeneous ventilation. Thus resulting in reduction in the difference between dorsal and ventral transpulmonary pressures, thereby reducing lung compression, and enhancing perfusion(9)

In February 2021 WHO stressed on the rampantly increasing demand for O2 and the essentiality of it for saving lives in the covid 19 pandemic. In India according to a report in April 2021 the daily consumption of oxygen was about 4000MT/DAY which increased to 11000 MT/DAY by MAY 2021 starting, leading to a humongous task of conservation of oxygen in COVID ICU's.Oxygen production in cryogenic air separation units is related to a significant carbon footprint and its supply in the medicinal sphere became critical during the recent COVID-19 crisis [15].Typical energy consumption in cryogenic units exceeds 200 kWh of electricity per ton of produced oxygen and is thus associated with significant environmental impact [13,14]. Various methods were put into action including preventing wastage of oxygen, using evidence based SPO2 goals along with avoiding hypoxia, considering use of oxygen conserving devices,use of liquid oxygen, frequent inspection and elimination of O2 leaks and considering ventilatory devices with minimal Bias flow and keep an account of same.

OBJECTIVE:

To study the reduction in consumption of oxygen by using proning as an adjunct to HFNO in patients of COVID 19 admitted in ICU.

METHODOLOGY

In this observational cross sectional study we collected data of patients admitted in COVID ICU during May - June 2021 from SVP Hospital, Ahmedabad, which was a designated tertiary COVID care centre during the pandemic. 26 (Twenty Six) Patients who were hemodynamically stable and required HFNO to maintain oxygenation in the COVID ICU were included in this study. After taking approval from the Institutional Review Board of our institution, verbal and written consent was taken from the patients. All patients were counselled for the benefits of proning. Proning was done with the help of nursing staff.

INCLUSION CRITERIA:

- Patients having COVID 19 and on HFNO.
- Patients who are hemodynamically stable.

EXCLUSION CRITERIA:

- Patients refusal
- Patients who are obese
- Patients with contraindicated conditions for proning.

As the patients were in ICU all the vitals i.e Pulse, Blood Pressure(BP), Respiratory Rate(RR) along with oxygen saturation(SPO_2) with the help of a multipara monitor were noted before and throughout proning. Due to the increased possible chances of Thrombosis and avoiding multiple needle pricks to the patients, ABGA was done only as and when warranted. We kept patients in a prone position till patients were comfortable and duration of proning was noted. We titrated oxygen requirement (FIO2 and flow) to target Spo_2 level of 93-95%.

A total of 4 to 5 pillows are a prerequisite for prone positioning,one pillow is placed below the neck one or two pillows placed below the chest through upper thighs and two pillows

below the shins.Pillows are adjusted slightly to alter pressures areas in accordance to the comfort of the patient.Proning is maintained for only as much times as it is easily tolerable to the patient.This manoeuvre was done multiple times a day as and when allowed by the patient, and they were encouraged to stay prone for maximum possible time.

Certain things to be cautious about while proning the patient:

- Proning should be avoided for an hour after meals.
- Proning should be maintained for only as much time as easily tolerated by the patient.
- Pillows are adjusted for comfort and to alter the pressure areas in order to avoid any pressure sores or injuries, around bony prominences.
- Proning should be avoided in pregnancy,deep venous thrombosis,major cardiac conditions,unstable spine,femur or pelvic fractures.

ETHICAL ASPECTS

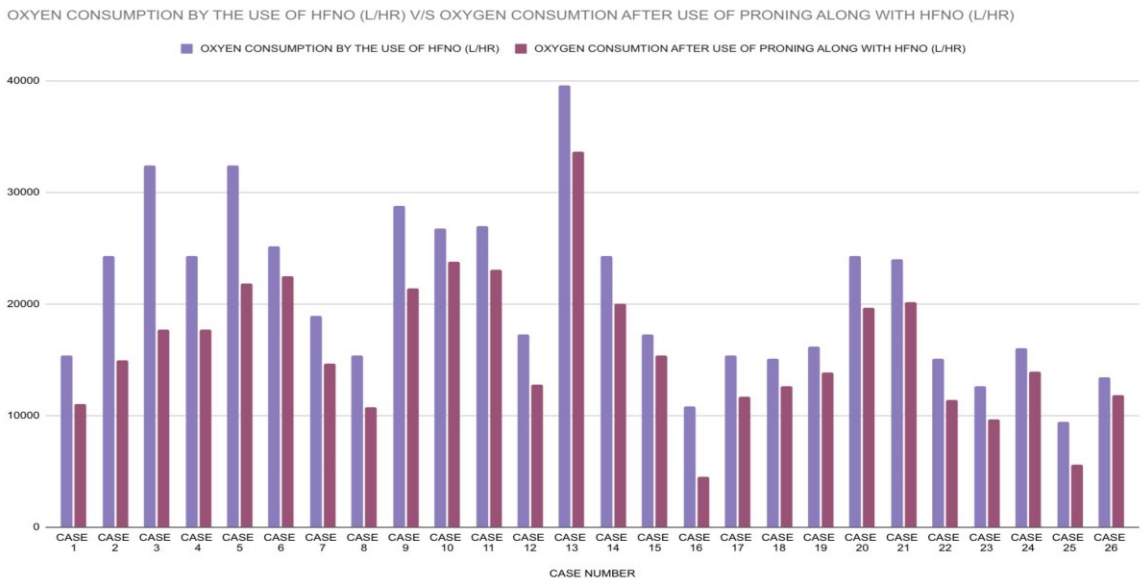
- All participants after enrollment are able to withdraw from the study or leave it at any point of time without any obligation to continue.
- Informed consent is taken from all the participants after providing all relevant information regarding the study.
- All the participants have the right to privacy, confidentiality will be maintained regarding all personal information.
- Research participants were not subjected to any harm in any ways whatsoever.

STATISTICAL ANALYSIS

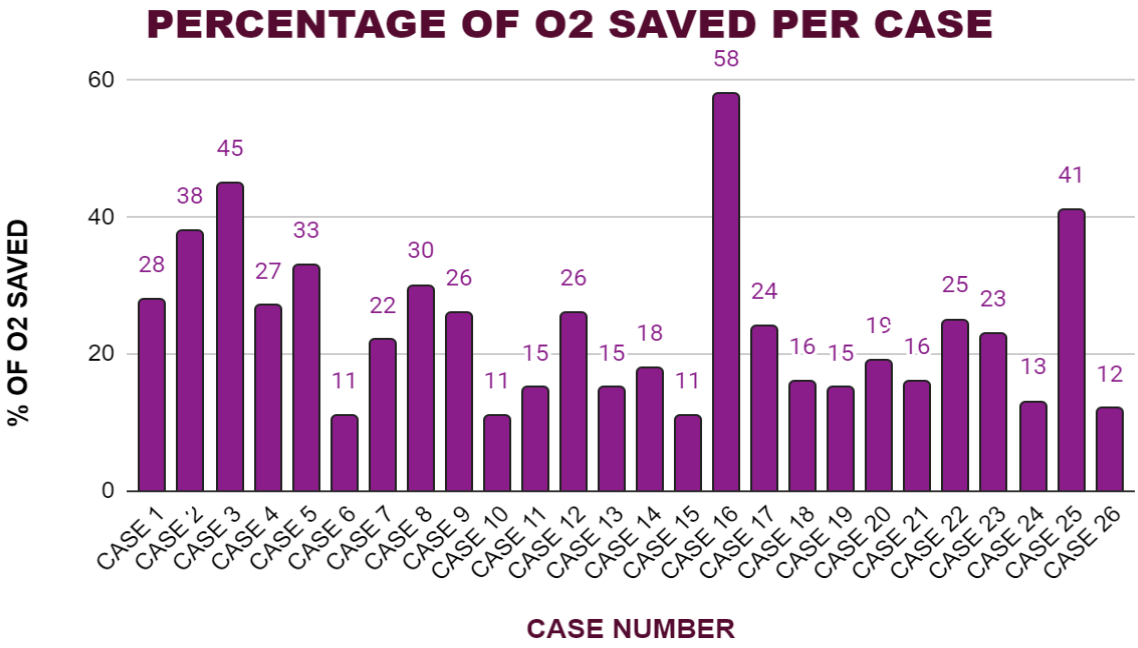
Statistical Package for Social Sciences (SPSS, version 20:SPSSInc. , Chicago, Illinois, USA) was used for statistical tests and analysis. Our data was analysed by using Unpaired t-test on basis of distribution of data. The p value of <0.5 is considered significant.

RESULT:

We studied in 26 patients on HFNO with proning, we found that proning helps in 11-50% reduction in oxygen requirement to achieve target Spo2 level. Patients maintained prone position comfortably for 2 to 4 hours ina single cycle and the same cycle was repeated during the whole day, totalling to average 6 to 8 hours/day. There was resistance from many patients for prolonged duration of proning. After giving a prone position, we found that the total amount of O2 reduction was min- 270 L/hour, max-2000 L/hour in our study. The amount of oxygen saved by the use of Proning along with HFNO was statistically significant with p value of 0.0154 which was statistically significant. The mean value of oxygen consumption was 20833.27 L/HR with only use of HFNO which was more than 15996.92 L/HR when patients were encouraged to be prone along with the use of HFNO. Obtained data of the total amount of oxygen used by HFNO alone (considering that the patient would have been kept on the same initial settings as the start of cycle throughout the observation period if proning would not have been done) and this was compared with the data of the amount of oxygen consumed when proning was done along with the use of HFNO. The collected data was analysed and unpaired t test was applied after which p value of 0.0154 was obtained, which is statistically significant.



Graph 1



Graph 2

Being a simple and safe intervention in co-operative patients, proning therapy has high potential for reducing icu resources. As we globally face resource depletion, we share the preliminary evidence of awake proning being a low risk, low- cost manoeuvre which helps patients of covid-19 pneumonia. We conclude that awake proning in HFNO not only improves oxygenation of patients with respiratory distress but also helps in reduction of oxygen requirement (by reducing O2 flow and fio2).

TOTAL AMOUNT OF OXYGEN SAVED (LITRE/HR) DUE TO PRONING ON HFNO						
CASE NUMBER	OXYGEN CONSUMPTION BY THE USE OF HFNO (L/HR)	OXYGEN CONSUMPTION AFTER USE OF PRONING ALONG WITH HFNO (L/HR)	TOTAL OXYGEN SAVED D/T PRONING (L/HR)	PERCENTAGE OF O2 SAVED PER PATIENT (%)	AVERAGE OXYGEN SAVED D/T PRONING	TOTAL HRS OF PRONING (HRS)
CASE 1	15360	11025	4335	28	541.875	8
CASE 2	24300	14970	9330	38	2073.33	9
CASE 3	32400	17700	14700	45	1336.363	9
CASE 4	24300	17685	6615	27	826.875	9
CASE 5	32400	21795	10605	33	1178.33	9
CASE 6	25200	22485	2715	11	543	7
CASE 7	18900	14670	4230	22	705	7
CASE 8	15360	10725	4635	30	662.142	8
CASE 9	28800	21405	7395	26	924.375	8
CASE 10	26730	23790	2940	11	490	9
CASE 11	27000	23040	3960	15	565.714	10
CASE 12	17280	12750	4530	26	755	9
CASE 13	39600	33630	5970	15	995	11
CASE 14	24300	19995	4305	18	717.5	9
CASE 15	17280	15345	1935	11	387	9
CASE 16	10800	4515	6285	58	897.857	4
CASE 17	15360	11700	3660	24	610	8
CASE 18	15120	12660	2460	16	492	9
CASE 19	16200	13830	2370	15	592.5	6
CASE 20	24300	19650	4650	19	664.285	9
CASE 21	24000	20130	3870	16	552.857	10
CASE 22	15120	11415	3705	25	617.5	9
CASE 23	12600	9675	2925	23	417.857	7
CASE 24	16065	13935	2130	13	304.285	7
CASE 25	9450	5595	3855	41	550.714	5
CASE 26	13440	11805	1635	12	272.5	7

DISCUSSION:

COVID-19 pneumonia is a specific disease whose distinctive features are severe hypoxemia often associated with development of ARDS. Developing Nations face massive crocus of resources and manpower during the pandemic. When patient is in prone position, there is reduction of Ventilation Perfusion mismatch due to homogeneous distribution of Oxygen. This, thereby, causes reduction of intrapulmonary shunting and leads to adequate sputum drainage due to opening of the atelectic lung areas(Improving oxygenation). Reduction of transpulmonary pressure gradient is also known to decrease barotrauma. Studies have shown

that, early application of prone positioning with HFNO in patients with moderate ARDS helps in avoiding intubation. It was also found that there is a significant improvement in the media P/F ratio, from day 1 to day 10 in patients of prone as compared to supine position. Prone positioning helped us to reduce the rate of intubation, which needs to be studied and further corroborated with appropriate statistical evidence. Prone position was tolerated well by majority of patients with symptom improvement. Thus, awake proning of COVID 19 patients with high flow oxygen therapy had benefits like cost effectiveness, lower risk, easy to tolerate and no higher skill required to perform. Many research supports that proning help in oxygenation in patients with respiratory distress as it has the benefit of-

❏ Better ventilation of dorsal lung regions threatened by alveolar collapse;

❏ Improvement in ventilation/perfusion matching; and

❏ Potentially reduction in mortality & morbidity.

The rampant increase in the number of COVID 19 cases lead to a major discrepancy in the demand supply chain of medical oxygen, which emphasised the judicial use and the need to conserve oxygen more than ever. Oxygen conservation is important not only during pandemics but also in routine use as industrial oxygen production leaves a significant carbon footprint leading to environmental impact.

LIMITATIONS:

Very less sample size (n=26)

Could not include varied age groups

CONCLUSION:

Based on this study it is concluded that there is significant reduction in consumption of oxygen by using the prone position as an adjunct to HFNO in patients of COVID 19.

ACKNOWLEDGEMENT: NIL
FUNDING: - NIL
CONFLICT OF INTEREST: NIL

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Unpaired *t* test results

P value and statistical significance:

The two-tailed P value equals 0.0154

By conventional criteria, this difference is considered to be statistically significant.

Confidence interval:

The mean of HFNO minus HFNO PLUS PRONE equals 4836.35

95% confidence interval of this difference: From 963.95 to 8708.74

Intermediate values used in calculations:

t = 2.5085

df = 50

standard error of difference = 1927.948

Review your data:

Group	HFNO	HFNO PLUS PRONE
Mean	20833.27	15996.92
SD	7521.29	6330.22
SEM	1475.05	1241.46
N	26	26