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Case Series

Prone position during ECMO in patients with COVID-19 in Morocco: Case series

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ABSTRACT

Introduction: The main manifestation of COVID-19 pneumonia is acute respiratory distress syndrome (ARDS), which in some cases can be more severe, requiring Veno-venous extracorporeal membrane oxygenation (VV-ECMO) to ensure hemostasis. Despite support from Veno-venous extracorporeal membrane oxygenation, some patients may remain hypoxemic. One possible therapeutic procedure for these patients is the application of the prone position (PP).

Objective: The aim of this study was to investigate the effect of VV-ECMO on arterial oxygenation and compliance of the respiratory system in mechanically ventilated patients with refractory hypoxemia. The secondary objective was to evaluate the safety and feasibility of prone position for ECMO.

Methods: We retrospectively reviewed the electronic records of all 23 COVID-19 patients on ECMO who were placed for the first time in prone position with an average duration of 16 h. Patient characteristics, pre-ECMO characteristics, changes in ventilator/ECMO settings and blood gas analysis before and after PP.

Results: A total of 23 position changes to prone position were performed. Oxygenation and respiratory compliance improved 16 h after adoption of prone position without any accidents during PP.

Conclusions: The use of prone position during Veno-venous extracorporeal membrane oxygenation demonstrated an improvement in oxygenation as well as lung compliance. It is a safe and reliable technique.

1. Background

The combination of prone position (PP) and extracorporeal membrane oxygenation (ECMO) could be good for patients with recurrent hypoxemia, especially in certain severe acute respiratory syndrome caused by coronavirus infection 2 (SARS-CoV −2). However, this combination could be associated with catastrophic complications such as dislocation of ECMO cannulas.

We study the benefit and modification of the oxygen effects of the supine position during extracorporeal membrane oxygenation (ECMO) to identify feasibility and discuss our results with some available data in the literature.

2. Objective

The main objective of the current study was to investigate the change in PaO2/FiO2 ratio, the compliance of the respiratory system in VV-ECMO patients with persistent hypoxemia. Measurements were taken before PP, 1 h after the start of the PP, at the end of the PP cycle.

The secondary objective of this study was to assess the safety and feasibility of emergency positioning for patients with severe ARDS during ECMO treatment.

3. Materials and methods

This was a single-center retrospective study conducted in the intensive care department of the University Hospital of Oujda, Morocco.

The design of the study is retrospective because Prone position and Veno-venous extracorporeal membrane oxygenation are an integral part of the treatment of ARDS patients.

All enrolled patients or their families have been informed that data from their ICU experience may be collected for research purposes. We

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retrospectively analyzed data from patients admitted during the SARV CO-2 pandemic period from February 2020 to December 2020, at the General Therapy Unit of Mohammed VI University Hospital, Oujda, Morocco.

Microsoft 'Excel' was used to utilize the information collected from the computerized patient database.

Twenty three patients admitted to the intensive care unit of either gender and different ethnicities were included. The most important inclusion criterion was a patient with ARDS after infection with SARS COV 2 and placed on right femoral-jugular VV ECMO and having refractory hypoxemia during Veno-venous extracorporeal membrane oxygenation (VV ECMO). Patients who received veno-arterial ECMO (VA-ECMO) and those receiving ECMO for reasons other than ARDS were excluded.

Measurements were taken before adoption of prone position, 1 h after the start of the PP and at the end of the PP cycle. Microsoft 'Excel' was used to utilize the information collected from the computerized patient database.

Access to patients' data was authorized by the Mohammed VI University Hospital. Given the retrospective design of this study, the requirement of patient's consents was waived. Anonymity of data was respected as per national and international guidelines. Our study was registered in Research Registry under the number: NCT04995289.

- This case series has been reported in line with the PROCESS Guideline [8].

4. Results

Twenty three COVID-19 patients were enrolled. They were placed in PP at least once with a mean duration of 16 hours (Fig. 1). Patient characteristics are shown in Table 1. Pre-ECMO characteristics, ventilator/ECMO settings and changes in ventilator/ECMO settings are listed in Table 2. Arterial blood gas analysis reports before and after PP are shown in Table 3.

No untoward incidents occurred during the PP procedure in any of the patients.

5. Discussion

Acute respiratory distress syndrome (ARDS), characterized by severe respiratory failure due to hypoxia, affects up to 10% of patients in the intensive care unit and is a common reason for the use of mechanical ventilation [1].COVID-19 pneumonia in its severe form meets the definition of ARDS according to the Berlin 2012 criteria. It differs from classical ARDS due to relatively preserved lung performance in the initial phase [3]. Patients with severe forms require prolonged mechanical ventilation in conjunction with prone sessions to improve ventilation/perfusion ratios and correct hypoxemia. When lung compliance decreases due to atelectasis and bacterial superinfection, the ventilation regimen should change to protective ventilation [4].

The prone position has been evaluated as part of the treatment of patients with ARDS since the 1970s. In patients with moderate to severe ARDS, prolonged prone position (at least 12 hours/day) has been shown to reduce mortality and is now the standard of care in treating these patients [5]. The analysis of primary endpoint mortality (60-day mortality) in the search for patients with very severe ARDS showed no superiority from the early onset of ECMO compared to a ventilation strategy [2]. However, patients often remain hypoxemic despite full ECMO support. The main determinants of peripheral oxygen saturation (SpO2) during Veno-venous extracorporeal membrane oxygenation (VV-ECMO) are pump flow, degree of recirculation, systemic venous return, oxygen saturation of the patient, hemoglobin concentration, and remaining lung function in cases where all parameters are normal.

Prone positioning (PP) with Veno-venous extracorporeal membrane

Table 1
The patient caracteristiques.

Age (years),[IQR]	59,86 [39–87]
Male sex (%)	65,21
Body mass index (kg/m2)[IQR]	30,26 [31,53–28,45]
Comorbidities	
Any (%)	60,86
Hypertension (%)	13,04
Diabetes (%)	26,08
Heart disease (%)	8,69
asthma (%)	8,69
fibrosis (%)	8,69

PEEP: positive end-expiratory pressure, FiO2:fraction of inspired oxygen, PaCO2: arterial partial pressure of carbon dioxide, PaO2 arterial partial pressure of oxygen, FDO2:fraction on oxygen delivered in the sweep gas, ECMO: extracorporeal membrane oxygenation, VV ECMO: Veno-venous extracorporeal membrane oxygenation.
**Data are expressed as number (%) or median [IQR]. Analyses were performed with the Excelle 2019. All tests were two-tailed, with α level at 0.05.
*RR: respiratory rate.

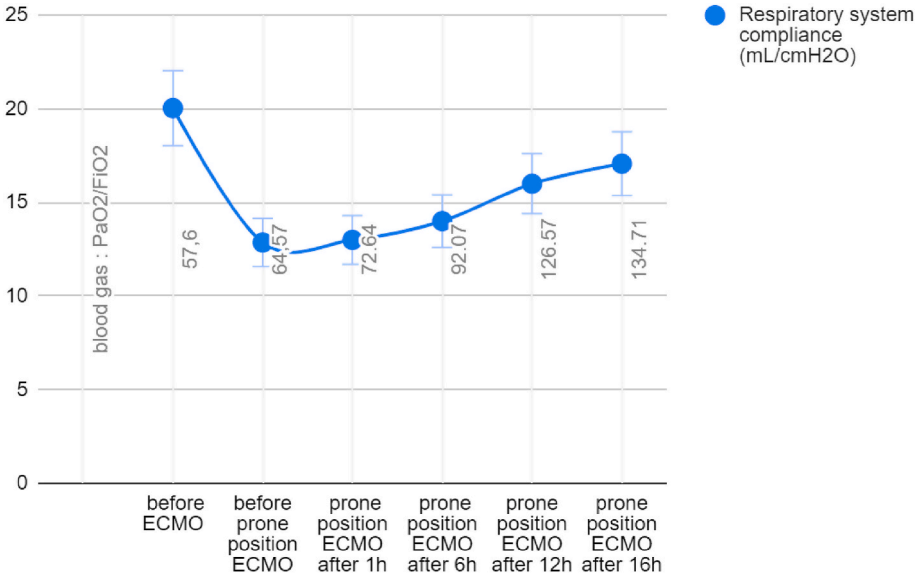

Fig. 1. The evolution of PaO2/FiO2 Ratio, Respiratory system compliance during PP ECMO VV COVID Patient.

Table 2
The Pre and post prone position ventilator and ECMO settings.

		before prone ecmo	before prone position	after 16h of prone position	*p value*
ECMO setting	ECMO blood flow (L/min) [IQR]	4,03 [3,5–4,5]	4 [3.5–4]	3.8 [3,5–4,3]	*0.037*
	Sweep gas flow (L/min)[IQR]	2,34 [1–3]	2,41 [2–3]	2 [1–3]	*0.18*
	Membrane lung fraction of oxygen (%)[IQR]	100	96,66 [80–100]	75 [60–90]	*0.013*
Mechanical ventilation settings	Tidal volume (mL/kg) [IQR]	416,52 [380–450]	186,66 [120–280]	285 [220–380]	*0.001*
	Plateau airway pressure (cmH 20) [IQR]	32,21 [30–36]	30	29 [27–30]	*0.05*
	PEEP (cmH2O) [IQR]	10,52 [8–14]	12,16 [10–15]	12,16 [10–15]	*0.5*
	Driving pressure (cmH2O) [IQR]	21,26 [12–28]	17,83 [15–20]	16,83 [15–20]	*0.15*
	Respiratory rate (cycles/min) [IQR]	21,82 [18–30]	12,5 [12–14]	12,66 [12–14]	*0.45*
	Respiratory system compliance (mL/cmH2O) [IQR]	20,04 [16–25,29]	12,86 [6,66–19]	17,07 [12,94–21,11]	*0.45*
	Inspired fraction of oxygen (%) [IQR]	100	100	66,66 [50–80]	*0.0017*

Table 3
Blood gas analysis before and after PP.

	blood gas before ECMO	blood gas before prone position ECMO	blood gas in prone position ECMO				*p value*
			after 1h	after 6h	after 12h	after 16h	
PaO2/FiO2 [IQR]	57,6 [39–86]	64,57 [48–69]	72,64 [57–92,5]	92,07 [75–112,5]	126,57 [90–216]	134,71 [110–200]	*0.0008*
PaO2 (mmHg) [IQR]	55,91 [39–80]	57,71 [48–69]	70 [57–81]	75,71 [58–90]	84,42 [59–130]	85,64 [62–120]	*0.046*
PaCO2 (mmHg) [IQR]	38,68 [26–56,5]	38,14 [31–51]	38,25 [32–40,9]	37,31 [32–41]	38,71[32–45]	37,85 [31–45]	*0.44*
pH [IQR]	7,43 [7,31–7,67]	7,36 [7,31–7,38]	7.33 [7,21–7,46]	7.32 [7,21–7,42]	7.36 [7,31–7,42]	7.29 [7,01–7,41]	*0.18*

oxygenation (VV-ECMO) can help optimize alveolar recruitment [6,7]. Twenty 4 h after adopting the combined strategies (VV-ECMO and PP), both oxygenation and compliance of the respiratory tract improved as demonstrated in our study. The mean PaO2/FiO2 of 57 mmHg before beginning ECMO improved to 64.7 with ECMO. One hour after placing prone on ECMO, PaO2/FiO2 increased to 72 mmHg at the end of 16 hours, 134 mmHg. The improvement of the PaO2/FiO2 ratio was accompanied by improved lung performance as demonstrated by reduction in FIO2 requirement as well as the driving pressure.

Prone position ventilation was without any problems, such as accidental extubation, or decrease of blood ECMO flow. These results are consistent with those found in the literature, mainly with results from the studies of Alberto Lutccini, which included 45 patients.[7] He showed that during the first prone position for each patient, the average registered PaO2/FiO2 ratio was 123 mmHg and suggested that combined Prone Position and Veno-venous extracorporeal membrane oxygenation have more beneficial effects in addition to improving oxygenation and this therapy is safe to do also may be beneficial for ECMO patients.

6. Conclusion

Prone position ventilation during ECMO is safe and improves oxygenation. This can ameliorate hypoxemia and reduce damage due to mechanical ventilation. The high mortality rate in patients with ECMO in the prone position can be explained by the greater severity of the disease.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Patient perspective

Patients did not express their perspective about the studie.

Sources of funding

This research was not funded.

Ethical approval

This is a retrospective case series that does not require a formal ethical committee approval. Data were anonymously registered in our database. Access to data was approved by the head of the department.

Consent

This is a retrospective study.

Author contribution

Dr. Oujidi Younes: are the principal investigators that collected and analyzed data, wrote the manuscript and prepared the final draft for the submission. Dr. Amine Bensaid,Dr Douaa Jakhjoukh, Dr.Layla Kherroubi and Dr. Iman Melhaoui: participate in patients' management. Prof. Brahim Housni and Prof. Houssam Bkiyer: supervised the research project and approved the final draft for publication All authors approved the final version of the manuscript.

Research studies

1. Name of the registry: ClinicalTrials.gov
2. Unique Identifying number or registration ID: NCT04995289
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): https://clinicaltrials.gov/ct2/show/NCT04995289?cntry=MA&draw=2&rank=1

Guarantor

Dr Oujidi Younes.

Declaration of competing interest

The authors declare no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2021.102769.

Abbreviation

ECMO	extracorporeal membrane oxygenation
VV-ECMO	Veno-venous extracorporeal membrane oxygenation
VA-ECMO	Veno-Arteial extracorporeal membrane oxygenation
ARDS	acute respiratory distress syndrome
PP	Prone position
COVID	coronavirus disease
SARS-CoV −2	syndrome caused by coronavirus infection 2
RR	respiratory rate
PEEP	positive end-expiratory pressure
FiO2	fraction of inspired oxygen
PaCO2	arterial partial pressure of carbon dioxide
PaO2	arterial partial pressure of oxygen
FDO2	fraction on oxygen delivered in the sweep gas

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