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Case report

Not just a matter of weight: A case report of ECMO treatment in a severely obese patient

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ABSTRACT

The ELSO Guidelines list a BMI $\geq$ 40 kg/m^2 among the relative contraindications to give ECMO treatment in SARS – COV2 patients. We describe a case of a 52-year-old with BMI 50.21 kg/m^2, admitted to the intensive care unit (ICU) with severe respiratory conditions and successfully treated with extracorporeal membrane oxygenation (ECMO). The application of veno-venous (VV) ECMO will evolve as far as we understand the pathophysiology of the COVID-19 disease and will probably have a determinant role in management of patient with refractory hypoxemia, whose ventilation management is difficult, even in case of severe obesity.

Introduction

Obesity is one major risk factor for severe coronavirus 2019 disease [1]; in fact, obesity increases probability of hospitalization, intensive care unit (ICU) admission, invasive mechanical ventilation requirement and finally death among patients with COVID-19.

The ELSO Coronavirus Disease 2019 Interim Guidelines list the absolute and relative contraindications to extracorporeal treatment in SARS-COV2 patients [2]. According to these guidelines, patients selection criteria should be strict, due to the pandemic setting and the limited ability to offer this resource-consuming treatment, privileging those patients who have better chance of survival. Specifically, a BMI $\geq$ 40 kg/m^2 is listed among the relative contraindications on the Guidelines, actually excluding most of the obese patients from ECMO treatment.

The aim of this case report is to describe a case of a 52-year-old with extreme obesity, successfully treated with ECMO in our hospital. Written informed consent was obtained from the patient for publication of this case report. This manuscript adheres to the applicable EQUATOR guideline.

Case description

The patient was admitted in our ICU on 10/02/2021 with diagnosis of severe Covid-19 pneumonia. He was affected by hypertension, was tall 184 cm and weighted 170 kg, with BMI of 50.21 kg/m^2.

On 05/02/2021, he was admitted to another hospital emergency department due to important dyspnea and started oxygen therapy with facial mask. He subsequently gradually deteriorated and started non-invasive ventilation (NIV) the 7th of February with increasing pressure support, positive end expiratory pressure (PEEP) and FiO2; he was then intubated on 10/2/2021 and transferred to our ICU. Antibiotic therapy with Azythromicine 500 mg once a day was already ongoing.

Deep sedation and neuromuscular blockade were then performed; mechanical ventilation was settled in pressure control with the following parameters: pressure support 22 cmH2O, PEEP 15cmH2O, respiratory rate 22 breaths per minute, FiO2 85%. Blood gas analyses showed: pH 7.38, paCO2 47 mmHg, paO2 74 mmHg, P/F ratio 87. On the following day, P/F ratio dropped to 55, so mechanical ventilation was switched to volume control with tidal volume 440 ml, PEEP 13 cmH2O, respiratory frequency 26/min, FiO2 0,95.

A chest computed tomography (CT) scan was performed on 11/02/21, showing presence of pneumomediastinum and pneumopericardium, multiple areas of altered parenchymal density “ground glass” like and bilateral parenchymal consolidations.

Fibro-bronchoscopy was than performed improving alveolar recruitment, and Pressure/Volume loop on the ventilator showed a lower inflection point of 13 cmH_2O and upper inflection point > 35 cmH_2O. Static compliance was 34 with Best PEEP of 13 cmH2O.

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Mechanical ventilation was continued with the same parameters, reducing FiO2 to 0,85. Further blood gas analysis showed persistent hypoxemia and mild hypercapnia, with P/F ratio value of 80. Unfortunately, pronation was not an option, due to the important patient weight.

After more than 12 h of severe refractory hypoxemia with P/F ratio ranging from 55 to 80, under the ultrasound guidance, a 25 Fr multistage Maquet inflow (drainage) cannula was inserted into the right femoral vein and a 22 Fr Euroset outflow cannula into the right jugular vein. The depth of drainage cannula was 55 centimeters, and the depth of arterial cannula was 14 centimeters. No complication occurred, and VV- ECMO treatment was initiated on 11/02/21, with 5 liter per minute blood flow and 2 liter per minute air flow, FiO2 100%. Standard anticoagulation therapy with intravenous heparin was started, to achieve a partial thromboplastin time (PTT) Ratio between 1,5 to 2 and an activated clotting time (ACT) ranging from 160 s to 200 s. Protective mechanical ventilation was then set with following parameters: tidal volume 400 ml, PEEP 21 cmH2O, respiratory frequency 8/min, FiO2 0,6; moreover, inhalator Nitrous Oxide was administered. Suddenly, blood gas analyses showed an improvement of the paO_2 (150 mmHg), with a $paCO_2$ of 49 mmHg.

On the following days, several bronchoscopy toilets were performed, removing multiple dense bronchial secretions and mucus plugs.

Bronchoalveolar lavage culture and tracheobronchial aspirate culture, nasal and rectal swabs and urine culture sampled on admission, resulted all negative. Consequently, antibiotic therapy with Piperacilline/tazobactam was stopped.

On the 14/02/21 VV- ECMO support was 5 lpm blood flow and 4.5 lpm air flow, FiO2 was 100%, Nitrous Oxide 15 ppm was still administered, and blood gas analyses showed a further improvement of PaO2 to 185 mmHg.

On the 15th of February a weaning trial was performed, with FiO2 100%, maintaining VV ECMO support. After 30 min paO2 improved up to 200 mmHg, so neuromuscular blockade with rocuronium was interrupted.

Empirical antibiotic therapy with meropenem, phosphomycine and colistine was started due to hyperpyrexia associated with raised inflammatory markers, based on our ICU presence of Klebsiella pneumoniae Carbapenemase and Acinetobacter Baumanii on other patients.

On the 16/02 patient was still on assisted ventilation with pressure support of 20 cmH2O and PEEP 22 cmH2O. VV ECMO air flow was reduced to 2 lpm, paCO2 was 38 mmHg, and paO2 was 147 mmHg on blood gas analysis.

The following day the patient was awakened, without any residual neurological issues. VV ECMO air flow was reduced to 1 lpm, without hypercapnia neither pH imbalance at the blood gas analysis. Blood oxygenation was settled steady around paO_2 95 mmHg.

On 19/02, on the eighth day of ECMO treatment, a temporary tracheostomy was placed, to achieve a short-term respiratory support and facilitate weaning. VV ECMO airflow was then closed for observation, while the patient was still in support ventilation with PEEP 22 cmH2O and FiO2 0,5. After 2 h of observation, blood gas analyses showed paO2 168 mmHg (P/F ratio 336), so VV ECMO was finally stopped.

CT scan performed on 24/2 showed important reduction of pneumomediastinum and resolution of pneumopericardium. Mediastinal shift was also reduced, and left lung was normally expanded again.

Ventilation support was gradually reduced on following day, and spontaneous breathing cycles started on March 2nd, with high flow oxygen therapy administration.

Patient recovered from COVID-related pneumonia and was moved to a rehabilitation center on March 15th, spontaneously breathing with Ventimask (FiO2 0,5), after two molecular swab negatives for Sars-CoV2 infection. Tracheostomy was also closed.

Discussion

Extracorporeal membrane oxygenation is a form of cardiopulmonary bypass where venous blood is drained from the patient and pumped through a membrane which provides oxygen and removes carbon dioxide. Its use in refractory respiratory failure allows super-protective ventilation with lower tidal volume (up to 4 ml/kg PBW) and lower driving pressure, better tissue oxygenation and better carbon dioxide elimination. Its use had been increasing in the last years for adult respiratory distress syndrome, showing some reduction in mortality compared to conventional mechanical ventilation [3]. From the very start of the pandemic ECMO has been used in specialized centers in China, with controversial results [4], and the WHO interim guidelines considers using it in its recommendations for treatment of ARDS [5]. There are still concerns about increased risk of serious complication (mainly acute renal failure, major bleeding, and mechanical issues) in patients treated with ECMO [6]. An international cohort study demonstrates 90-days mortality of COVID-19 patients treated with ECMO consistent with previous data on ECMO-supported patient with acute respiratory failure [7,8].

In this report, we described a case of VV ECMO treatment on a super obese patient (BMI 50,21 kg/m^2) with refractory severe hypoxemia Sars-CoV2 pneumonia related. VV ECMO has been sometimes used for treating hypoxemia and hypercapnia due to severe ARDS, even in this pandemic [9]. Yet, this treatment is not broadly available, due to cost, limited resources, and the need of highly specialized personnel. Moreover, there is limited data on efficacy, since the only available data come from case reports and few observational studies. The ELSO Coronavirus Disease 2019 Interim Guidelines list the absolute and relative contraindications to the extracorporeal treatment in SARS-COV2 patients, and BMI $>$ 40 kg/m^2 is indicated as relative contraindication. Our patient weighted 170 kg, was affected by pneumomediastinum and ARDS; unfortunately, due to his obesity, pronation was not an option.

ARDS diagnosis is based on the Berlin definition and classified into three groups (mild, moderate, severe) depending on PaO_2/FiO_2 ratio [10]. Patients with COVID-19 develop ARDS in 20–67% of hospital admission and up to 100% in those mechanically ventilated [11]. Many patients respond well to protective mechanical ventilation with low tidal volume and to pronation. However, some patients show reduced static pulmonary compliance, forcing to further reduce tidal volume to maintain airway plateau pressure under 30 cmH_20. Those patients develop severe hypercapnia with concurrent acidosis. Furthermore, COVID-19 pneumonia is associated to pulmonary thrombotic injury and increased D-dimer levels [12].

The significant treatment goals for patients with COVID-19 pneumonia-associated ARDS is to maintain blood oxygenation and CO2 removal; this must be done maintaining low airways plateau pressure, to limit the ventilation-induced lung injury.

The role of VV ECMO applied in patients with severe COVID-19 related ARDS, anyway, remains marginal.

Indication to VV ECMO in this pandemic are limited to selected patient, intubated, and mechanically ventilated for less than 7 days, with poor blood gas exchange although best mechanical ventilation management.

We strongly believe that the application of VV ECMO will evolve as far as we understand the pathophysiology of the disease and will probably have a determinant role in management of young patient with refractory hypoxemia, whose ventilation management is difficult, even if severely obese.

Moreover, we think that the decision whether to initiate or not to initiate a life-saving treatment should not be entirely based on numbers. The cornerstone of our clinical practice should always be the patient, considering his clinical history, his features and how he responds to other treatments. Sadly, we witnessed young and healthy patients struggle with this disease until death. On the other hand, some unexpected patients responded better and finally made it to recovery (Fig. 1).

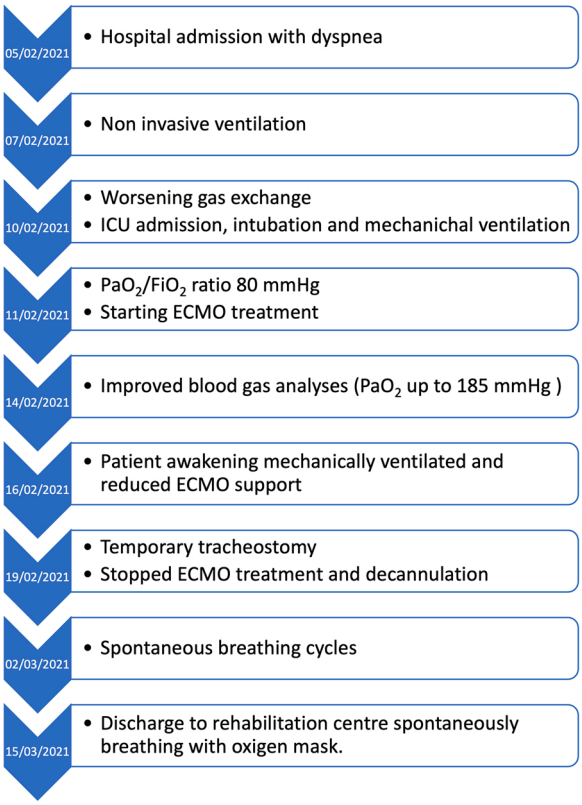

Fig. 1. Timeline with the most prominent characteristics of the COVID-19 patient.

VV ECMO may serve as an additional treatment modality in morbidly obese adult patients with acute respiratory failure that does not respond to maximal conventional ventilation support, but more studies on obese population are needed to fully understand the potential of its application.

Statement of ethics

In our center ethics approval is not required for case reports.

Consent to publish statement

Written informed consent was obtained from the patient for publication of this case report.

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CRediT authorship contribution statement

L. Schiavoni: Conceptualization, Methodology, Software **A. Mattei**: Data curation, Writing- Original draft preparation. **G. Pascarella**: Visualization, Investigation. ***C. Piliego:*** Supervision, Writing and Editing.**G. Biondo**: Software, Validation, Reviewing and Editing. **A. Strumia:** Writing- Reviewing and Editing. **F.E.Agrò**: Supervision, Software, Validation.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Data availability statement

Data in the article are available on request.

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