

Case Report

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Successful ECMO Decannulation after (103 Days) Due to COVID-19 Infection: A Case Report

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ABSTRACT

We present a case of a 41-year-old COVID-19 positive male; he was intubated for severe acute respiratory distress syndrome (ARDS). He continued to have refractory hypoxemia despite positive pressure ventilation, prone positioning, and the use of neuromuscular blockade. Considering ECMO support, a multidisciplinary team evaluated the case and he was initiated on venovenous ECMO (V-V ECMO). His prolonged ECMO course was complicated with many different challenges but eventually, he showed a remarkable improvement in his lung functions. ECMO was successfully decannulated after 103 days of initiation. He was then weaned from mechanical ventilator (MV) with closure of tracheostomy and later on discharged home on low dose supplemental oxygen.

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Introduction

Extracorporeal Membrane Oxygenation (ECMO) utilization to support Coronavirus Disease 2019 (COVID-19) patients is remarkably increasing since the beginning of the pandemic. This case of native lung recovery, after more than a hundred days of ECMO, supports the reported positive possibilities of lung healing and avoidance of salvage lung transplant after severe COVID-19 infection and prolonged ECMO support.

Case Report

A 41-year-old obese male with no significant medical history presented with the main complaints of fever and dyspnea of 8-day duration. In the emergency room, he was found to have tachypnea and desaturation (84%). Laboratory testing of blood revealed lymphopenia, elevated C-reactive protein and ferritin levels. Computed tomography (CT) of the chest revealed bilateral ground glass infiltrates in keeping with severe COVID-19 induced lung changes. (Figure 1: A, B). A PCR swab for SARS-CoV-2 came positive; he was admitted to the medical ward and received supplemental oxygen by non-rebreather mask. However, he continued to deteriorate and developed progressive desaturation and respiratory distress requiring shifting to the ICU and escalation of his support to high flow nasal cannula (HFNC) then intubation and connection to mechanical ventilation.

On day 9 post intubation, he continued to have refractory hypoxemia despite positive pressure ventilation, prone positioning, and the use of neuromuscular blockade. The Respiratory Extracorporeal Membrane Oxygenation Survival Prediction Score (RESP) was 1, with a predicted survival of 57% [1]. After consultation between members of the multidisciplinary team (MDT), the patient was cannulated for VV-ECMO. The right jugular vein and right femoral vein was cannulated with Maquet cannulas

19 Fr; and 23 Fr respectively. Initially, the rotation speed of the ECMO system was set to 2500–3000 rpm according to the blood oxygen saturation and blood pressure. Blood flow was controlled to about 3.0–4.0 L/min. Blood-gas analyses were monitored every 4 hours to achieve acceptable PCO₂ and oxygen levels. While the oxygen concentration of the ECMO system remained at 100%, the mechanical ventilator was set to target ultra-protective lung ventilation [positive end expiratory pressure (PEEP) = 10 cmH₂O, Peak pressure: 10-12 cmH₂O, respiratory rate = 10 b/m, VT < 4 mL/kg and FiO₂ of less than 50%] [2].

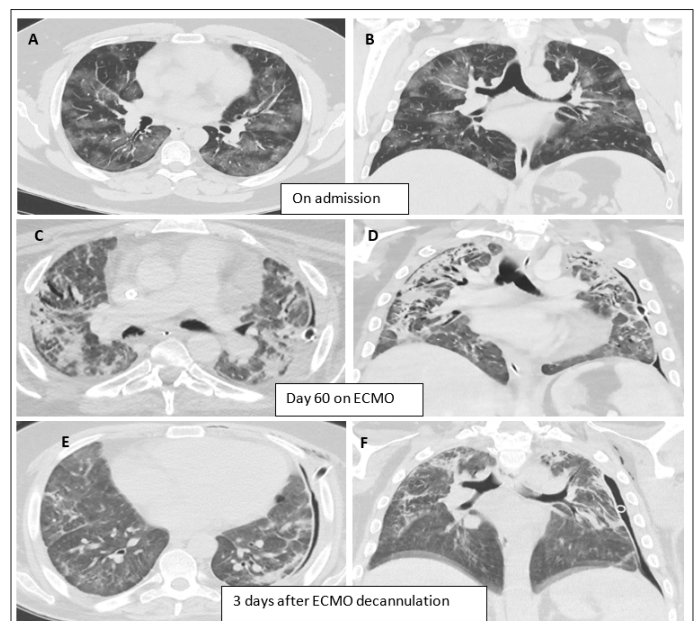


Figure 1: Computed tomography (CT) of the chest upon hospital admission showing extensive ground-glass opacities (A and B). CT at 70 days of admission (Day 60 on ECMO): Diffuse bilateral fibrocystic lung disease and Left-sided mild pneumothorax with

chest drain in situ (C and D). CT at 116 days of admission (3 days after ECMO decannulation) showing bilateral organizing infiltrates/fibrotic changes with the number of inflammatory infiltrates is significantly reduced (E and F).

His prolonged stay in the ICU was complicated with multiple episodes of sepsis and septic shock as well as bilateral pneumothorax requiring placement of bilateral ICD. He remained fully dependent on VV ECMO due to resistant hypoxemia. The ECMO circuit was changed in different occasions due to circuit clot and oxygenation failure.

Eventually with the improvement of his lung functions and overall clinical condition, the oxygen flow in the ECMO system was weaned gradually until it was closed for observation up to 72 hours. After that he was decannulated after 103 days of ECMO support. Over the next few days he was successfully weaned from the MV. CT chest showed significant reduction in the number of inflammatory infiltrates (figure 1: E and F). Later, he had his tracheostomy closed then he was shifted to the ward for continuation of rehabilitation and medical management. He was discharged home on low dose home oxygen.

Timeline	
Time	Event
Day 1	Admitted to hospital with fever and dyspnea. He was found to have tachypnea and desaturation. Laboratory testing revealed lymphopenia and elevated C-reactive protein, procalcitonin and ferritin levels. CT of the chest revealed bilateral severe groundglass infiltrates. PCR swab came positive for SARS-CoV-2.
Day 2	Shifted to ICU, intubated and connected to MV due to ARDS and respiratory failure.
Day 10	Cannulated for V-V ECMO
Day 20	Bilateral pneumothorax requiring bilateral ICDs insertion.
Day 30	Re-intubated after unsuccessful extubation aiming for awake ECMO. Later percutaneous tracheostomy was done
Day 82	Accidental decannulation of Rt IJ cannula. Immediately reinserted with change of the ECMO circuit
Day 113	ECMO decannulation after careful weaning and vigilant observation for 3 days while gas sweep is off.
Day 124	Tracheostomy decannulation
Day 131	Shifted to the medical ward for rehab and continuation of medical care
Day 146	Discharged home on oxygen support and stable general condition

At the most recent follow-up (2 months after ECMO decannulation), he received respiratory and cardiac rehabilitation. He was maintaining oxygen saturation more than 94% on low flow oxygen and he was able to walk 500-1000 steps per day without exhaustion.

Specific Challenges

MV Management and Refractory Hypoxemia

After initiation of ECMO and to allow for lung rest with minimizing the lung injury, ultra-protective lung ventilation with permissive hypoxia was started together with careful monitoring the mechanical power.

The tidal volume was found to be very correspondent to disease progression and lung recovery as shown in figure: 2. Awake ECMO trial was not successful and tracheostomy was done to facilitate mechanical ventilation.

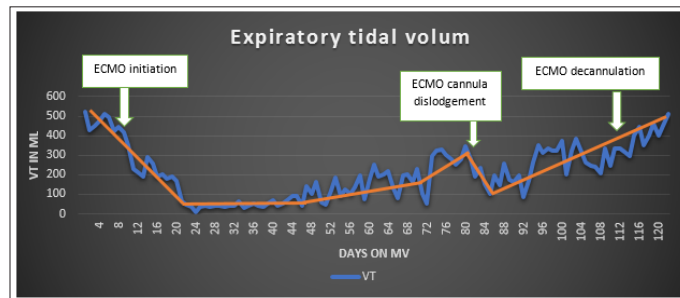


Figure 2: Showing tidal volume progression during ECMO support. Ultra-protective lung strategy was implemented and VT was noted to drop significantly with mean VT of 99.3 ml during the first 30 days following ECMO initiation then gradually improving.

ECMO Related Challenges

Coagulation, Bleeding and Filter Change: Coagulation function was monitored after initiation of ECMO and heparin infusion using bedside activated clotting time (ACT) every 4 hours. ACT of 180-200 was targeted. The oxygenator needed to be changed four times during the ECMO course due to oxygenator failure monitored by post oxygenator PO₂, unexplained rise in D-Dimer and increase in the delta pressure. The average lifespan of the oxygenators was 25.7 days.

ECMO Cannula Dislodgment: On day 82 of ECMO support, the patient had accidental dislodgement of the return cannula inserted in the right Internal jugular. He was immediately re-cannulated with the circuit changed. He needed packed red blood cells transfusion and vasopressor support for a few days after this incident.

High Pulmonary Artery Pressures and Right Ventricular Dysfunction

Despite the respiratory improvement, it was difficult to wean off the ECMO support. Echocardiography revealed right ventricular (RV) dilation with significant RV dysfunction and high pulmonary artery (PA) pressures (60-70 mmHg). Oral sildenafil was started but with very little effect. With the aim to treat high PA pressure in real time, PA catheter (Figure: 3A) was inserted and revealed high pulmonary pressures (Figure: 3B). The patient was started on inhalational prostacyclin (iloprost) and later on prostacyclin injection which helped to decrease the PA pressures significantly and improved the right ventricular function before ECMO decannulation.

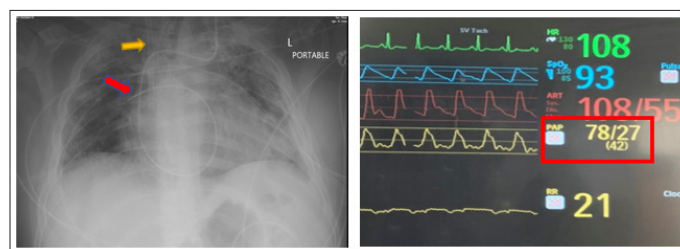


Figure 3 A: CXR showing the PAC in place (red arrow) and ECMO cannula in the right internal jugular vein (yellow arrow). **B:** screenshot from the patient's monitor showing high PAP (red box)

Discussion

ECMO is a resource-intensive therapy and particularly prolonged support might influence ICU capacities and human and financial resources things that might be limited in a pandemic situation [3,4].

The ELSO registry data from 2009 to 2018 reported 4,361 adult patients who underwent prolonged ECMO for non COVID-19 respiratory failure, 88% of which received VV ECMO. The median ECMO duration was 22 days with a mean of 28±20 days [5].

COVID-19 patients appear to need prolonged ECMO run to allow for native lung recovery [6,7].

Most of the ECMO units consider being on mechanical ventilator for 7 days or more as a relative contraindication to ECMO initiation. In our case, the patient was considered for ECMO on day two after starting MV but it was not started until day 9 due to unavailability of ECMO machine at that time.

The timing of ECMO initiation appeared to have a great influence on the prognosis possibly due to the existence of advanced stages of the disease when ECMO was introduced. Therefore, earlier ECMO initiation could improve patient outcome and should be further investigated [7,8].

Dreier E, et al looked for potential factors that could indicate the need for prolonged ECMO support in severe COVID-19 cases. They did not find any differences between the short-term and prolonged ECMO group in demographics [7]. Similar to findings in a study on long-term (≥ 3 weeks) VV ECMO for non-COVID-19 ARDS [9]. Rather than demographic factors, severe endothelial injury could play a crucial role in the need for prolonged ECMO support as it might take more time to recover. That was also supported by the postmortem studies of COVID-19 patients showing an increased frequency of endothelialitis and thrombosis [10].

Dreier E, et al found that lung compliance tended to need more time to increase in patients with prolonged support. Nonetheless, native lung recovery was achieved in those patients after several weeks of therapy. Therefore, lack of improvement of lung function in the first weeks of ECMO or even temporarily worsening should not be seen as an indication to stop treatment [7]. Moreover, prolonged ECMO run was not in itself a predictor of death [11].

Most of previous studies on prolonged ECMO support (> 28 days) were done on H1N1-related ARDS. Data on prolonged ECMO support not related to COVID-19 and on follow-up of patients treated with ECMO for more than 28 days is limited. A recent analysis of risk factors for complete recovery of adults after VV ECMO treatment for respiratory failure indicated that long-term ECMO (≥ 2 weeks) had negative effects on complete recovery [12]. In contrast, further studies showed promising outcomes after median ECMO durations between 34 and 39 days [13-15]. In our case, VV-ECMO was maintained for 103 days and successful weaning with good recovery of lung function was achieved in a patient with severe COVID-19.

Another case report from China has shown possible native lung recovery and successful hospital discharge even after extended ECMO support of more than 100 days in COVID-19 patient. Future studies are still needed to determine the long-term effects of COVID-19 induced lung injury following the use of prolonged ECMO [16].

Conclusion

Prolonged ECMO support might be challenging due to unavoidable major complications. However, prolonged ECMO can be associated with positive outcomes in severe respiratory failure due to COVID-19 in highly selected patients and specialized centers. Weaning from V-V ECMO is feasible even after prolonged ECMO courses and salvage lung transplant could be avoided with proper ICU management (eg; hemodynamics, fluid status, MV management, sepsis treatment, etc.) which is of paramount importance and could have an immense impact on survival rates.

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