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Awake extracorporeal membrane oxygenation in a patient with COVID-19 pneumonia and severe hypoxemic respiratory failure

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Abstract. – OBJECTIVE: In the past few years, extracorporeal membrane oxygenation (ECMO) has been increasingly used in patients with severe respiratory insufficiency in whom mechanical ventilation (MV) had failed. MV in severe COVID-19 patients is often accompanied by high respiratory pressures and high oxygen concentrations. Thus, by "placing the lungs at rest" ECMO might spare severe COVID-19 patients from being subjected to aggressive MV. Awake ECMO is another therapeutic alternative for providing extracorporeal oxygenation and ventilation by avoiding the complications of MV.

CASE PRESENTATION: A 65-year-old male diagnosed with COVID-19 pneumonia was admitted to the intensive care unit (ICU) after deteriorating to hypoxemic respiratory failure with acute respiratory distress disorder (ARDS).

Awake veno-venous (VV) ECMO was considered after receiving patient consent and was successfully implemented as an attempt to avoid invasive MV. This is one of the first cases described during the COVID-19 pandemic, in which awake VV-ECMO was used in a critically ill COVID-19 patient as a replacement therapy to conventional MV.

CONCLUSIONS: Under the appropriate conditions, awake ECMO might be a suitable alternative approach to avoid complications of aggressive MV in selected critically ill COVID-19 ARDS patients.

Key Words:
COVID-19, Acute respiratory distress syndrome, Awake extracorporeal membrane oxygenation, Intensive care unit.

Introduction

Veno-venous extracorporeal membrane oxygenation (VV-ECMO) is increasingly used in patients with severe respiratory failure who are unable to ventilate or oxygenate on conventional mechanical ventilation (MV)[1]. Reports[2,3] of awake VV-ECMO, in non-intubated spontaneously breathing patients, were first described in candidate patients for lung transplantation serving as a bridge to transplantation. Retrospective analysis indicated that lung transplant candidates on awake ECMO had better survival than patients placed on MV[4].

The main advantage of awake ECMO is the opportunity to avoid invasive MV and minimize the complications associated with sedation and intubation[5]. The disadvantages of awake ECMO are related to patient discomfort by dealing with pain, anxiety, and conscious awareness to ECMO. As with any ECMO, and perhaps even more so in awake ECMO patients, catheter dislodgment or disconnection is a genuine and feared possibility. Furthermore, awake ECMO requires skilled staff, is labor intensive and carries a large burden on the intensive care unit (ICU) staff[6].

To date, acute respiratory distress disorder (ARDS) in mechanically ventilated COVID-19 patients is associated with high mortality[7]. Despite major progress in the use of ECMO in ARDS COVID-19 patients since the pandemic started, mortality rate remains high, especially in patients with comorbidities[7,8]. We present a critically ill patient admitted to the ICU with severe COVID-19 infection that was treated effectively and successfully with awake ECMO as an alternative therapy to conventional MV.

Case Report

A 65-year-old male, with a past medical history of colon cancer treated with hemicolectomy and chemotherapy, pulmonary embolism, atrial fibrillation, and obesity, arrived at the hospital with

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complaints of high fever and effort dyspnea. The patient was previously diagnosed with COVID-19 infection one week before hospital admission. In the emergency room, the patient was tachypneic with 30 breaths per minute; room air oxygen saturation (SpO_2) was 88%, corrected with oxygen nasal cannula to 95%. Blood laboratory tests showed a high white blood cell count, lymphopenia and a high C reactive protein (CRP) level. Chest X-ray revealed bilateral pulmonary opacities compatible with ARDS due to COVID-19 infection (Figure 1A).

Since the patient had tachypnea (>30 breaths per minute), low SpO_2 (<94%) and lung infiltrates >50% (ARDS), he was defined as severe COVID-19 patient and was admitted to the COVID-19 ward. The patient received therapy with high flow nasal cannula (HFNC) 40 liters/min, steroids (dexacort), antiviral therapy (remdesivir) and COVID-19 convalescent plasma therapy (two doses). Due to advanced respiratory insufficiency, the patient was transferred to the ICU.

In the ICU, the patient was still tachypneic with more than 30 breaths per minute. Measured SpO_2 was 93% on combined HFNC $FiO_2$70%/liter and reservoir oxygen mask 15 liter/minute of O_2 support. Despite attempts to improve patient's oxygenation with HFNC, hypoxemia further aggravated. Chest X-ray showed severe ARDS (Figure1B). In an attempt to avoid MV and taking into serious consideration the patient wishes not to resume invasive MV, awake extracorporeal support was initiated with VV-ECMO. The procedure underwent without complications. After the insertion of the jugular and femoral vein cannulas, chest X-ray showed appropriate jugular vein cannula placement (Figure 1C).

On VV-ECMO blood flow of 3 liters, FiO_2 80% and HFNC FiO_2 50%/liter, the patient's clinical state improved dramatically with a significant decrease in respiratory rate to normal (14 breaths per minute). Concomitantly oxygenation improved with an increase of SpO_2 to 90-92%. The patient was awake, able to communicate and fed by himself.

During the ensuing days oxygenation has steadily improved along with significant clinical and radiological improvement. After six days, the patient was disconnected from the VV-ECMO without any complications. Chest X-ray showed significant improvement and complete resolution of the previous bilateral opacities (Figure 1D). The patient continued to be supported with HFNC FiO_2 40%/liter with SpO_2 98%. After 5 days the patient was resumed to oxygen nasal cannula 3 liter/minute and maintained satisfactory SpO_2. Finally, the patient was weaned from oxygen support and was able to maintain SpO_2 97% on room air. After treating the patient for 12 days, he was discharged from the ICU to a recuperation centre and has returned to normal daily activities.

Discussion

In this case report, we present our personal ICU experience with awake VV-ECMO and the outcome of a critically ill patient with COVID-19 respiratory infection and severe ARDS.

Awake ECMO is an alternative approach to avoid barotrauma and ventilator induced lung injury (VILI) which is associated with the use of aggressive MV[9].

Awake ECMO in selected patients has the advantages of maintaining respiratory muscles and diaphragmatic tone, preventing ventilator acquired pneumonia and decreasing ventilation-perfusion mismatch[10]. Another advantage of awake ECMO is that it spares the patient the need for sedation and maintaining spontaneous breathing which is associated with generation of negative intra-thoracic pressure that may result in increased venous return and positive effect on cardiac output[11].

Suitable patient selection for awake ECMO depends on patient's level of consciousness, optimal patient cooperation, hemodynamic stability, PaO_2/FiO_2 ratio, positive end-expiratory pressure requirement, the need for noninvasive use of ventilation and comorbidities such as obesity, diabetes, hypertension and chronic lung disease[9,12].

In our case, the considerations for using awake ECMO were supported by the patient's medical compliance and the patient's full cooperation, hemodynamic stability, and the patient's request not to be intubated.

High mortality rates were reported in ICU patients with ARDS that were treated with MV due to VILI. ECMO is a suitable solution for avoiding prolonged but necessary MV in critically ill patients admitted to the ICU[13]. It has been suggested that ECMO might decrease the mortality rate of COVID-19 ARDS[14], yet the use of awake ECMO in patients with ARDS is still controversial. First reports indicated a mortality rate of 33%[15]. Other reports[16,17] were more favorable, indicating that awake ECMO was successful in a patient with ARDS due to septic shock who was not a candidate for noninvasive ventilation[16] and in a cohort of patients

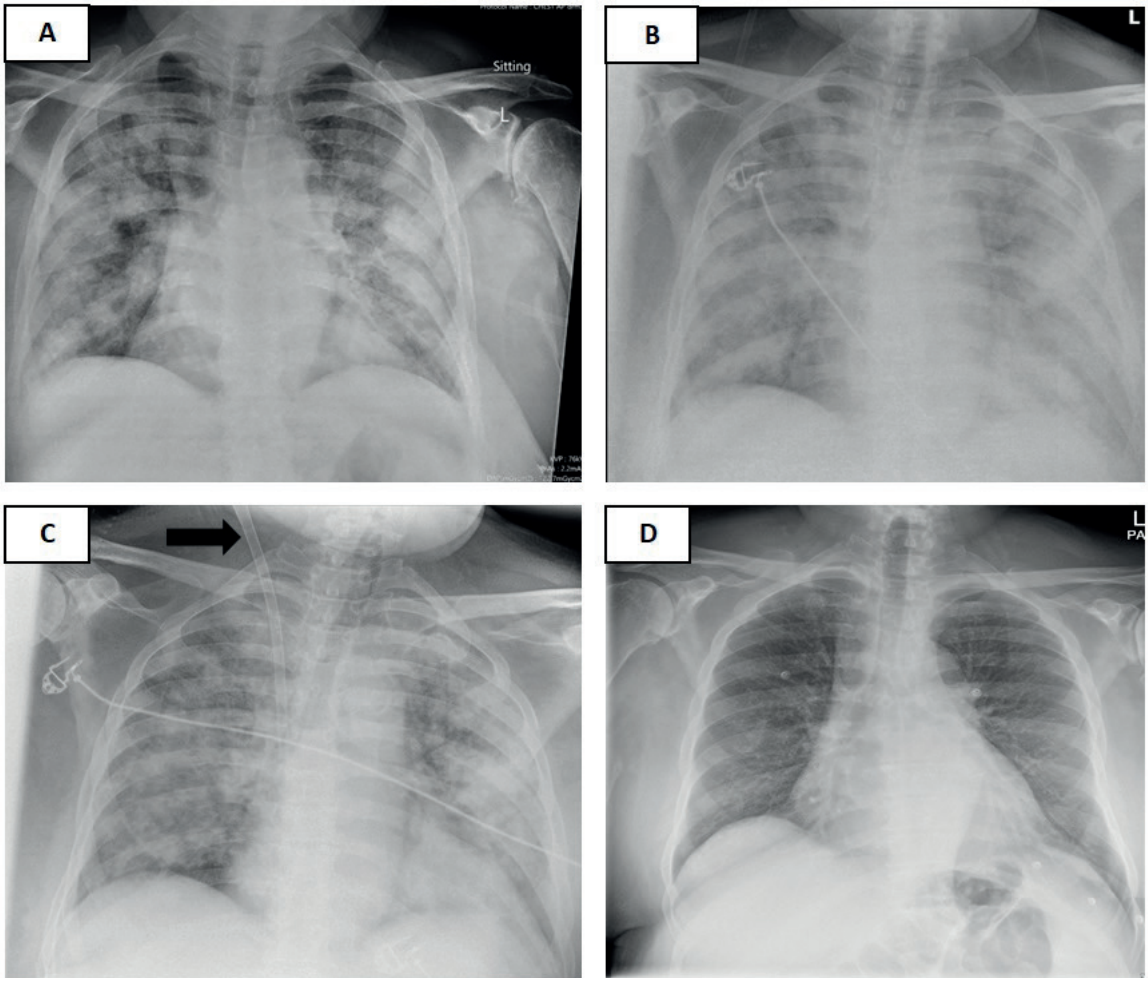

Figure 1. Posterior-Anterior (PA) chest X-ray showing bilateral lung opacities compatible with acute respiratory distress syndrome (ARDS), on patient's admission to the COVID-19 ward (**A**) severe ARDS with bilateral lung infiltrates on patient transfer to the intensive care unit (ICU) (**B**) after awake veno-venous extracorporeal membrane oxygenation (VV-ECMO) right jugular cannula insertion in the ICU (black arrow) (**C**) complete resolution of ARDS on discharge (**D**).

after severe postoperative ARDS as a weaning strategy to avoid long-term use of MV[17].

To date, two other case reports[18,19] on the successful use of awake ECMO in ARDS patients with COVID-19 were published. The first case described an 80-year-old female patient who was admitted to the ICU with severe bilateral pneumonia[18]. The second case was of a 49-year-old female patient with COVID-19 and severe ARDS[19]. We present an additional case report of successful awake ECMO in a critically ill COVID-19 ARDS patient.

Conclusions

Based on our personal experience and supported by few case reports, awake ECMO might be an appropriate alternative approach to prevent MV complications in selected critically ill COVID-19 ARDS patients admitted to the ICU.

Conflicts of Interest

The authors declare no conflicts of interest.

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