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First successful treatment of COVID-19 induced refractory cardiogenic plus vasoplegic shock by combination of pVAD and ECMO – a case report

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Abbreviations:

ICU Intensive care unit

ICD implantable cardioverter-defibrillator

NYHA New York Heart Association

PiCCO Pulse Contour Cardiac Output device

ARDS acute respiratory distress syndrome

pVAD Peripheral ventricular assist device

ECMO Extracorporeal membrane oxygenation

ELSO Extracorporeal Life Support Organization

Abstract

The novel coronavirus SARS-CoV-2 is infecting hundreds of thousands of humans around the globe. The coronavirus disease COVID-19 is known to generate mild as well as critical courses. Complications on the intensive care units include acute respiratory distress syndrome, acute cardiac– and kidney injury as well as shock.

Here, we present the first case report of a successful treatment of a COVID-19 patient presenting with ARDS plus refractory combined cardiogenic and vasoplegic shock, which could be successfully stabilized after implantation of a percutaneous ventricular assist device (pVAD) plus an extracorporeal membrane oxygenation (ECMO).

While such intense treatment might not be feasible in case of a health care disaster as described for the hot spots of the COVID-19 pandemic, it might encourage treatment of younger patients on intensive care units not overcrowded by critically ill patients.

Introduction

The novel coronavirus SARS-CoV-2 is infecting hundreds of thousands of humans around the globe and represents one of the mayor health care disasters as defined by the world health organization WHO. A recent meta-analysis reports mortality to be as high as 13.9% in all patients with highest mortality in older patients[1]. While the development of the adult respiratory distress syndrome (ARDS) is the most common trigger for intensive care unit (ICU) admission (incidence 32.8%), cardiac injury and shock are frequent (incidence 13.0% and 6.2%, respectively)[1]. While these numbers derive from an all-comer COVID-19 collective, hemodynamic complications might be far more frequent in COVID-19 patients requiring ICU admission. To this date, there is insufficient data in order to comment on the prognosis of COVID-19 patients with hemodynamic complication like shock.

Patient Information

We report the case of a 52-year-old gentleman (79kg and 176cm) with known history of dilated cardiomyopathy, who presented in the emergency department with dyspnea and fever. As for his medical history, he was recently dismissed from our cardiology ward after suffering from an acute myocardial infarction and implantation of an implantable cardioverter-defibrillator (ICD) with New York Heart Association (NYHA) Functional Classification heart failure class II and was scheduled for cardiac rehabilitation. Apart from the heart failure, the patient had no significant comorbidities (see figure 1A).

Clinical Findings

At the emergency department (day 0), the initial clinical presentation was interpreted as acute on chronic heart failure with pulmonary congestion (see figure 1B) and the patient was transferred to our cardiology ward for diuretic and empiric antibiotic treatment. At the time of transfer to the ward, he was on 3.0 l/min of oxygen without dyspnea. During the first night in hospital, a rapidly increasing oxygen demand developed and the patient was transferred to our ICU for noninvasive ventilation for pulmonary congestion in the early morning hours. The

chest x-ray on ICU showed a significant increase of the bilateral infiltrates (see figure 1C). A SARS-CoV-2 PCR test returned positive that day.

Beside the moderate acute respiratory distress syndrome (ARDS) (as graded by the berlin classification), the patient developed a combined cardiogenic and vasoplegic shock. Advanced hemodynamic monitoring using the Pulse Contour Cardiac Output device (PiCCO®, Pulsion Medical Systems SE, Feldkirchen, Germany) showed a reduced cardiac output with 1,8l/min/m^2 in addition to a severe vasoplegia. We started levosimendan and norepinephrine, but the combined shock persisted. An empiric SARS-CoV-2 therapy was initiated with a combination of lopinavir and ritonavir plus chloroquine. The shock however could not be resolved through day two and was complicated by an acute kidney failure.

Percutaneous ventricular assist device (pVAD): To counteract the cardiogenic shock we implanted a peripheral ventricular assist device (Impella® CP Smart Assist, Abiomed, Aachen, Germany) at day three. Implantation was performed in the catheterization laboratory and did achieve a stable blood flow of 3.5 l/min. Left ventricular end-diastolic diameter (as determined by bed side ultrasound studies) and the left ventricular end-diastolic diameter (as determined by the Impella® CP Smart Assist) decreased and lactate levels returned to normal. However, the vasoplegic shock persisted, requiring continuous maximum vasopressor therapy.

Extracorporeal membrane oxygenation (ECMO): For the profound vasoplegic shock, a veno-arterial ECMO (Stöckert centrifugal pump console, SCPC®, Sorin Group, Munich, Germany) was added at day four using a bifemoral cannulation, initially running at a blood flow of 4.5 l/min and a sweep gas flow of 1.5 l/min at 100% oxygen. Vasopressor doses could be significantly reduced at day 7 as the vasoplegic shock resolved. We switched the venoarterial ECMO to veno-venous using a femoro-jugular configuration. During this switch procedure, the pVAD offered a sufficient hemodynamic support and unloading.

Course on Intensive care unit: The first week on ICU was dominated by the combined shock, whereas the respiratory situation was well controlled. The course however was complicated by a severe COVID-19 associated ARDS. Sequential chest x-rays showed a rapid progression of bilateral opacities (see figure 1 D). The Impella CP® was weaned at day 19. The veno-venous ECMO however is still running (blood flow 2.0l/min, sweep gas flow 1.5l/min at 60% oxygen). The therapy of our patients is still ongoing (day 24).

Discussion

We report a case of COVID-19 complicated by severe mixed, cardiogenic and vasoplegic shock. Shock might be an uncommon but life threatening complication of a SARS-CoV-2 infection. Giving the high number of infections however, an incidence of shock in 6.0% of all of COVID-19 patients[1] translates in a significant number of patients.

As reported here, the combined shock necessitated 17 days of mechanical circulatory support but could be overcome. This might be important for other patients presenting in shock complicating COVID-19 since, at least in our patient, the ARDS is the long lasting, persistent complication and not the shock. While such intense treatment might not be feasible in case of a health case disaster as described for the hot spots of the COVID-19 pandemic, it might encourage treatment of younger patients on intensive care units not overcrowded by critically ill patients.

There have been reports on a cytokine storm syndrome in COVID-19 patients which we believe was responsible for the vasoplegic shock[2]. Unlike the hyperinflammatory state in most VA-ECMO patients, which results in capillary leakage and high volume therapy to these patients[3], our patient discussed here presented with a fluid lung without leakage to the rest of the body. This made our patient a good candidate for mechanical support devices which are dependent on venous or ventricular drainage. Importantly, as the ARDS still persists, the prognosis is now driven by the potential pulmonary recovery. We do not have sufficient data on this very sick patient collective in order safely estimate prognosis. At least in our patient,

the shock could be overcome using a combination of two mechanical support devices. This case might encourage the community in preparing for extracorporeal treatment in COVID-19 patients[4] as well as sharing all data, for example in the registry of the Extracorporeal Life Support Organization (ELSO).

Conclusions

This is the first published case report of a COVID-19 patient presenting with a combined cardiogenic and vasoplegic shock which could be hurdled by a combination of pVAD and ECMO. Cardiac support was needed for 17 days while ARDS persisted longer. This might suggest that prognosis of COVID-19 is driven by ARDS.

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Figure legend

Figure 1. Chest x-ray. A: day -3, day of discharge. B: day 0 at the emergency department. C: day +1 at admission on ICU. D: day +10.

Figure 2: Time course of the COVID-19 disease

Figure 1

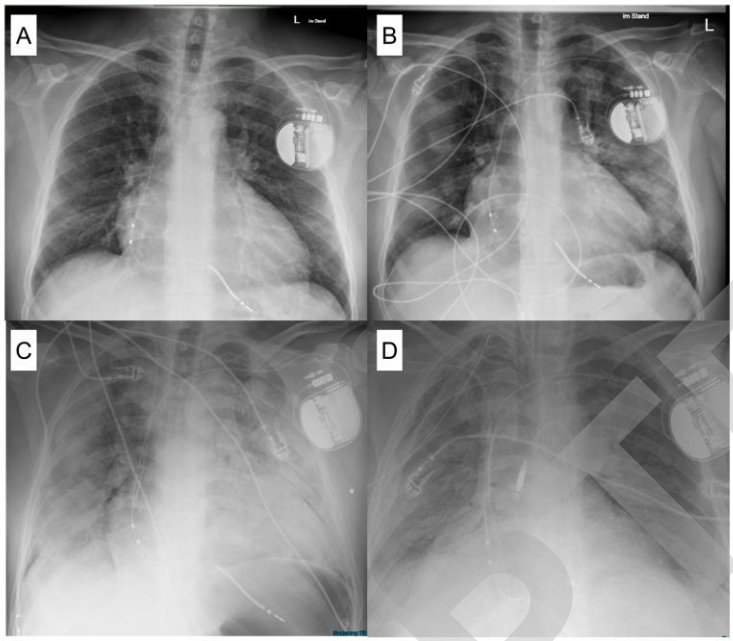

Figure 2