Covid 19 and ECMO support after neonatal congenital heart surgery: a case report

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Abstract

Coronavirus disease (COVID-2019) causes respiratory and systemic disease, has led to a sudden epidemic that affects people of all ages. The presence of cardiovascular comorbidities is associated with a higher risk of death. Therefore, patients with congenital heart disease represent a high risk population. When respiratory failure develops and mechanical ventilation is not sufficient due to Covid 19, extracorporeal membrane oxygenation (ECMO) may use as a form of rescue therapy. In this article, we present a newborn who required ECMO support for acute respiratory failure in the early postoperative period due to coronavirus 2 (SARS-CoV-2) after the aortic arch repair and ventricular septal defect closure operation. To the best of our knowledge, this patient was the first neonate case of SARS-CoV-2 infection after congenital heart surgery and was the youngest patient to receive ECMO support.

Introduction

The coronavirus disease pandemic, the illness caused by severe acute respiratory distress syndrome coronavirus 2 (SARS-CoV-2) was first announced in an adult in China on 17 November 2019, and The World Health Organisation (WHO) inform the epidemic of SARS-CoV-2 as a Emergency of International Concern on January 30, 2020 (1,2).

There are rare data, particularly on infants and neonates with congenital heart disease (CHD) and children with CHD are considered to have a high risk to get COVID-19. Babies with CHD continue to be born at the rate of 1 in 100 live births during the pandemic, and approximately 25% of these are considered critical CHDs requiring surgery or other interventions in the first year of life. (3). History of cardiac surgery may be associated with the risk of hospitalization in the intensive care unit (ICU), intubation and mechanical ventilation, which is a more severe form of the disease in newborns and children (4).

In this report, we present the management of SARS-CoV-2 infection in the newborn after successful repair of aortic arch and ventricular septal defect (VSD) closure surgery. Although extracorporeal membrane oxygenation (ECMO) support was applied twice due to respiratory failure, the patient died due to multiorgan failure. To our knowledge, this patient was the first newborn to receive ECMO support for SARS-CoV-2 infection after congenital heart surgery. The consent was obtained from the family for the publication of this study.

Case Report

A full-term 16 day old and 3,5 kg weight newborn boy was admitted our department with absence of femoral pulses and suspected coarctation of the aorta. Echocardiography(ECHO) revealed an arcus aorta hypoplasia with important aortic coarctation (35- 40 mm hg gradient with diastolic extension) and the diameter of proximal transvers arch was 4,9 mm (z-score -3,27), the diameter of distal transvers arch was 4 mm (z score

-2,62), and the diameter of isthmic arch was 2,8 mm (z-score -4,29). She also had restrictive muscular outlet ventricular septal defect with no evidence of left ventricular volume overload**,** bicuspid aortic valve with mild stenosis**,** left aortic arch, systemic pulmonary hypertension. There was no abnormality in the patient's preoperative laboratory values, and the neonate did not have a fever or cough preoperatively.

Surgical repair was performed with median sternotomy and cardiopulmonary bypass (CPB) was performed. During the arch repair, the antegrade cerebral perfusion was initiated (ASCP) and the del Nido cardioplegia was given. Aortic arch was reconstructed with anterior patch augmentation technique and VSD was closed with pericardial patch via right atriotomy. After the cessation of CPB, modified ultrafiltration was performed and the skin was closed with a patch, leaving the sternum open. The patient was transferred to the intensive care unit with moderate doses of inotropic supports, and in stable hemodinamic condition. The CPB, the aortic cross-clamping time, and the ASCP time were 152 min ,75 min, and 35 min respectively. In the control ECHO examination, no significant gradient was observed on arkus, and no residual VSD was detected. Peritoneal dialysis was started in the postoperative period. Sternum was closed on the postoperative day 2 uneventfully. Laboratory tests included normal white blood cell (WBC) count (6.2 ku/ul, ref range <= 4 ku/ul) with elevated 77,9% polymorphonuclear neutrophils, with low lymphocyte count of 750 cells/mm3 (ref range <=800 cells/mm3) on the postoperative day 2. The lymphocyte count (570 cells/mm3) was lower than the previous day, and C-reactive protein (CRP) levels (7.7 mg / dL, ref interval <= 0.5 mg / dL) were higher on the postoperative day 3.

Acute respiratory deteriation was occurred with refractory hypoxemia and worsening hypercapnia despite lung protective ventilation and high positive end-expiratory presssure (PEEP) theraphy on the postoperative day 3 (Figure 1). Extracorporeal membrane oxygenation (ECMO) support was used because of acute respiratory dysfunction on the postoperative day 4. Venoarterial ECMO support was initiated via 14 Fr venous cannula into the right atrium and 8 Fr arterial cannula into the ascending aorta. ECMO support was started at flow rate of 100 ml/kg/min (80-140 ml/kg/min) and arterial waveform demonstrated normal pulsatility. WBC count decreased to 4 ku/ul with elevated 72% polymorphonuclear neutrophils, and with low lymphocyte count of 690 cells/mm3. The patient's reverse transcription-polymerase chain reaction (RT-PCR) testing for SARS-CoV-2 was positive with the sample taken from the endotracheal tube on the postoperative day 4. Hydroxychloroquine and favipiravir theraphy was started immediately and given during 7 days. Heparin infusion was started and activated clotting time was maintained with in the goal range of 180-220. We did not see major complications as thrombosis or bleeding during the ECMO support. The initial echocardiogram on ECMO showed normal LV systolic function. The patient weaned from ECMO after 6 days support. Since oxygen saturation decreased and respiratory functions deteriorated 7 days after leaving ECMO, the ECMO support was applied again. After 18 days of care including hydroxychloroquine and favipiravir theraphy RT-PCR testing for SARS-CoV-2 was changed negative; however, there was no significant improvement in the patient's clinical condition. During these periods, the patient's sternum being open also made the patient vulnerable to infections in addition to Covid 19**.** Candida parapsilosis mediastinitis was occurred, and Sterotrophomonas maltophilia reproduced in blood culture during second ECMO support. Unfortunately, the patient could not survive and died on ECMO due to sepsis and multiorgan failure despite extended antibiotic theraphy on the postoperative day 28.

Discussion

It is necessary to understand that though the majority of children are not seriously affected, there may be a subset of group children where the COVİD-19 can progress rapidly deteriorate the respiratory functions (5). Our patient is the youngest patient ever reported with the progression of SARS-CoV-2 to severe disease requiring ECMO support after cardiac surgery. The respiratory deterioration of this case is important for understanding SARS-CoV-2 disease in newborns undergoing cardiac surgery. Our patient, who developed rapid respiratory disorder in the early postoperative period, was required ECMO support within the next 24 hours despite lung protective ventilation and high PEEP theraphy.

Current evidence shows that excessive inflammation, oxidation and an extreme immune reaction play a significant role in the pathogenesis of COVID-19 (6). Direct myocardial damage via angiotensin-converting

enzyme 2, viral pneumonia, acute respiratory distress syndrome (ARDS), acute lung injury, hypoxia induced myocardial damage, CPB related systemic inflammatory response syndrome, pulmonary hypertansion related to CHD may subscribe to inflammation course (6). Moreover, these events cause a cytokine storm and results in ARDS (6). The immunity of the patients has a major influence on the COVID-19 seriousness, and those with low immune function, such as neonates, may be more susceptible, especially after CPB (6).

According to the Extracorporeal Life Support Organization (ELSO) registry as of 5 December 2020, ECMO support was used in 3543 confirmed SARS-CoV-2 patients and in hospital mortality was 45% (7). Thrombosis and bleeding complications are well-known risks of ECMO support. Some studies announced a 70% incidence of bleeding and a 37% incidence of thrombosis complications in children supported by ECMO (8). But ECMO experience and literature is restricted in the SARS-CoV-2 disease (9). Kaushik et al. reported a 5-year-old male patient who underwent ECMO support with carotid artery cannulation due to SARS-CoV-2 multisystem inflamatory syndrome (9). Unfortunately, right anterior and middle cerebral artery infarction occurred on ECMO day 6 and finally the patient succumbed to. The cause of stroke, for in this case, may be multifactorial such as SARS-CoV-2 associated thromboembolic complications or carotid artery cannulation strategy. A single-center reported a 5% incidence of acute ischemic stroke on 221 patients with SARS-CoV-2, and in addition, the incidence of ECMO-associated stroke in children is known to be between 5.6% and 7.8% (10,11).

In our case, ARDS findings started on the postoperative 3rd day and the respiratory functions of the patient deteriorated rapidly. Considering that thromboembolic complications associated with SARS-CoV-2 may increase, veno arterial ECMO support was applied with central cannulation. Maybe for this reason, we did not observe thromboembolic neurological complications, which may give symptoms such as anisocoria or decrease in NIRS values during a total of 17 days of ECMO support.

The results of ECMO support in ARDS due to Covid 19 are associated with high mortality. Henry et al. reviewed 234 COVID-19-related ARDS patients in China, 17 of whom (7.25%) received ECMO, with a mortaliy rate of 94.1% in ECMO patients compared to 70.9% in conventional patients (12). In our opinion, in addition to having undergone cardiac surgery in the neonatal period, high ECMO mortality rates in ARDS due to COVID-19 negatively affected survival in our patient.

Conclusion

Because little is known about the clinical course and progression of SARS-CoV-2 infection in newborns after cardiac surgery, the duration of ECMO support, cannulation and anticoagulation strategy, and the recovery timetable to guide treatment is unclear. Our case emphasizes the clinical course of this disease leading to mortality, as well as the difficulties in managing ARDS and ECMO in the context of SARS-CoV-2 syndrome, especially in newborns who underwent cardiac surgery.

Data Collection and Availability

Data collection was performed by review from our institution. The data that support the findings of this study are available from the corresponding author, [author initials], upon reasonable request.

Funding

None

Conflict of interest

None

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Figure Legends

Chest radiography (CXR) during hospitalization. A) CXR on the postoperative day 2 after sternum was closing. B) CXR on the postoperative day 3. C) CXR after central cannulation to VA ECMO. Venous cannula in the right atrium and arterial cannula in the ascending aorta. D) CXR after weaning from the first ECMO support.