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CASE REPORT

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Left ventricular assist device implantation following multisystem inflammatory syndrome in children due to SARS-CoV-2

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Abstract

Multisystem inflammatory syndrome in children (MIS-C) is rare, however, severe hyperinflammatory condition in children generally weeks after acute SARS-CoV-2 infection. A subset of MIS-C patients is presented with severe heart failure. We hereby report 8-year-old girl presenting acute severe left ventricular failure. Various medical treatments including inotropic agents and drugs related to SARS-CoV-2 infection and MIS-C were applied. However, venoarterial extracorporeal membrane oxygenation (ECMO) was needed to be performed. Due to unsuccessful attempts for ECMO weaning, left ventricular assist device was implanted to the patient with temporary right ventricular support from ECMO.

KEYWORDS
heart failure, left ventricular assist device, MIS-C, SARS-CoV-2

1 | INTRODUCTION

At the onset of the COVID-19 pandemic, it was stated that children were protected from serious diseases, and only 2%–6% of patients suffered from serious illness.[1] After a while, multisystem inflammatory syndrome in children (MIS-C) was defined. It is a rare but severe hyperinflammatory condition in children and adolescents which generally emerge 2–6 weeks after acute SARS-CoV-2 infection.[2] Several definitions for MIS-C were revealed. Fever, evidence of inflammation, multisystem organ involvement such as cardiac, gastrointestinal, hematological, dermatological, neurological, renal manifestations in addition to laboratory confirmation of SARS-CoV-2 infection are necessary for the diagnosis. Cardiac manifestations of MIS-C include myocarditis, left ventricular dysfunction, coronary artery dilatation or aneurysm, arrhythmias.[3] Management of heart failure in these patients may require mechanical ventilation, inotropic support and in rare cases, extracorporeal membrane oxygenation (ECMO).[4] Up to now, left ventricular assist device (LVAD) implantation for severe left ventricular dysfunction related to MIS-C has not been reported. In this case, we presented an 8-year-old girl with MIS-C diagnosis who underwent LVAD implantation.

2 | CASE REPORT

Eight-year-old girl patient was admitted to the hospital with fever and abdominal pain. Due to recent COVID-19 pandemic, SARS-COV-2 reverse transcription-polymerase chain reaction (RT-PCR) assay was also evaluated and resulted as positive. After 3 weeks of out of hospital of follow-up, she was hospitalized with tachypnea, tachycardia, and hypotension. Echocardiography revealed severe left ventricular dysfunction with 10%–15% of left ventricular ejection fraction (LV-EF) and moderate level of mitral and tricuspid regurgitation. Laboratory measurements were as follows at their peak levels: creatinine: 1.16 mg/dl, aspartate

aminotransferase: 1081 U/L, alanine aminotransferase: 753 U/L, B-type natriuretic peptide: 18.254 pg/ml, troponin: 9.16 µg/L, C-reactive protein: 95.2 mg/L, ferritin 1.106 ng/ml.

After the initial inotropic support and diuretic treatment, mechanical ventilation was needed, despite respiratory support. Intravenous immunoglobulin and high dose methylprednisolone were initiated for immunomodulation. Anakinra was also used as IL-1 blocker. Due to the severe cardiogenic shock, venoarterial ECMO cannulation was performed. After 2 weeks of ECMO support, the patient was referred to our center.

Our VA ECMO weaning protocol is based upon Extracorporeal Life Support Organization guidelines. During weaning, VA ECMO flow is decreased progressively by 500 ml every 10–30 min concerning the medical status. Parameters must be fulfilled after weaning are mean arterial pressure >60 mmHg, central venous pressure <10 mmHg and low dose inotrope dependence. In this period, patient is evaluated with frequent blood gas analyses, concerning oxygenation, and lactate levels. In terms of this protocol, the patient could not be weaned from ECMO. LVAD implantation was planned.

The HeartMate 3 left ventricular assist device (HeartMate 3 LVAD) (Abbott Corp.) implantation was performed via standard median sternotomy on cardiopulmonary bypass (Figure 1). A temporary right ventricular support with ECMO was also implemented. During the operation, a sample from myocardium was taken for histopathologic confirmation. It was reported as ischemic necrosis secondary to MIS-C as depicted in Figures 2, 3, 4.

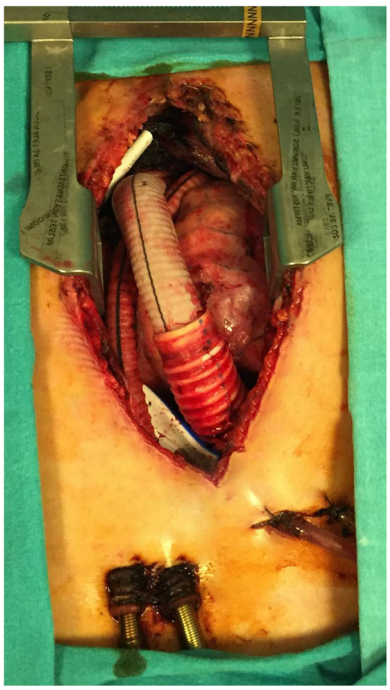

FIGURE 1 Intraoperative view of LVAD implantation. LVAD, left ventricular assist device

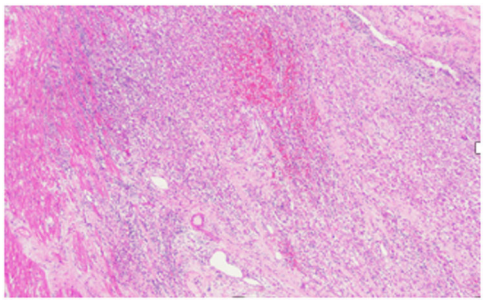

FIGURE 2 Histopathologic confirmation indicating large subacute myocardial infarction (H&E 200)

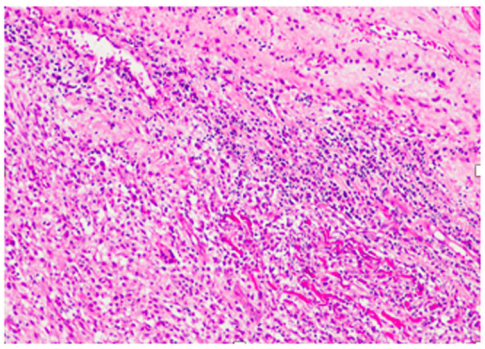

FIGURE 3 Degenerated cardiomyocytes and lymphohistiocytic infiltration with scarce giant cells (H&E X200)

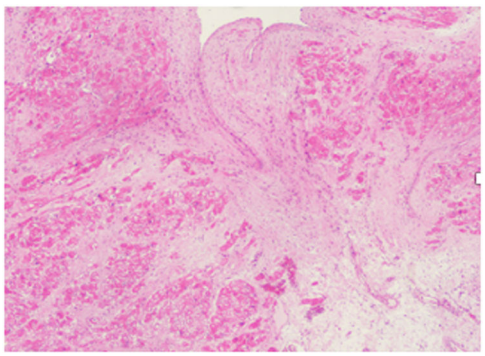

FIGURE 4 Subendocardial scar areas and chronic ischemic changes of subendocardial myocytes

After 1 month of follow-up in intensive care unit, unfortunately the patient died due to severe right ventricular and respiratory failure.

3 | DISCUSSION

In this case report, we demonstrated the use of LVAD for the management of severe left ventricular heart failure linked to MIS-C. After long period of ECMO support, LVAD was applied in a pediatric heart failure patient.

In terms of the published cases, there is no clear association between preexisting cardiovascular disease and MIS-C development. This statement also applies to our case.

Although our case is RT-PCR positive, it is variable according to the literature. IgG antibody positivity is seen at higher rates. This could demonstrate the role of the immune response in the pathogenesis of the disease.[5]

Characteristic presentation of MIS-C includes fever, gastrointestinal symptoms, and rash similar to our case except for rash. Abdominal pain can be severe enough to mimic appendicitis[6] 60% of MIS-C patients are admitted to intensive care unit and mortality is nearly 2%.[7] A subset of MIS-C patients is presented hypotension and shock as sign of severe cardiac dysfunction. Underlying mechanisms for myocardial dysfunction are explained as multifactorial. Cardiomyocyte injury due to acute or postviral immunological reaction, microvascular dysfunction, viral invasion, and ischemic injury could be responsible.[8] Beljander et al.[4] demonstrated a case series of 35 MIS-C patients with LV-EF <50%. Mechanical ventilation and inotropic support were used in most of the patients. ECMO support was needed in 10 of these patients who all weaned off ECMO without mortality. Another study reported by Feldstein et al.[9] enrolled 186 patients with MIS-C. ECMO support was required in 8 patients, 5 of these patients were discharged.

Coronary artery dilatation or aneurysms are also seen in this syndrome in 6%–24% of the patients.[1] We did not detect any dilatation in coronary arteries in our case. However, long term follow-up, which is not possible for our case, is needed for the development of coronary artery dilatation or aneurysms.

Differential diagnosis of MIS-C and Kawasaki disease (KD) is a topic of interest. KD is a vasculitis affecting medium-sized vessels, usually under the age of 5. Although, the etiology is not clear, it is thought that an inflammatory condition develops associated with some viruses, including coronaviruses. Fever over 5 days, in addition to at least 4 of following 5 conditions are needed: bilateral nonpurulent conjunctivitis, skin rash, cervical lymphadenopathy, oral mucosa changes, and changes in peripheral extremities such as erythema and desquamation.[1,10] Our case did not have comprise diagnostic criteria of KD. Coronary aneurysm or dilatation is also seen in 20%–25% of untreated KD patients that is a similar ratio in MIS-C patients.[11]

Mechanical circulatory assist devices have emerged a therapeutic option for patients with end-stage heart failure.[12] To the best of our knowledge, after the use of ECMO support, LVAD has not implanted for the treatment of MIS-C related severe acute heart failure.

There are some potential learning points related to the case. Right ventricular failure after LVAD and stiff lung due to long duration of ECMO were the determinants of mortality. LVAD implantation should be considered in these patients, but early planning without failure of the right ventricle will increase the chance of success. This is also applicable for heart transplantation. A biventricular assist device can be considered when both ventricles are impaired, but it is unlikely in children with such low weight. Therefore, it reduces the chance of success in this patient group.

4 | CONCLUSION

LVAD can be applied in severe left ventricular dysfunction associated with MIS-C. If circulatory support is not established, despite medical treatment and ECMO, LVAD should be considered in early period. Otherwise, mortality rates may be high in pediatric population.

ETHICS STATEMENT

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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