Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

(636 μg/liter), troponin T (high sensitive, 80 ng/liter), and N-terminal proB-type natriuretic peptide (833 ng/liter). Electrocardiogram revealed left anterior fascicular block and T-wave inversion in lead aVL (Figure 1a, 12-lead electrocardiogram). Screening tests for other viruses (Adenovirus; Coronaviridae 229E, HKU1, NL63, OC43; Human Bocavirus; Metapneumovirus; Rhinovirus/Enterovirus; Parainfluenza 1−4) were negative. Severe acute respiratory syndrome coronavirus 2 infection was reconfirmed in the laboratory. Because troponin was rising (191 ng/liter), coronary angiography was performed on March 23, 2020, and epicardial stenosis was excluded, but left ventricular (LV) end-diastolic filling pressure was elevated at 14 mm Hg. Echocardiogram performed on the same day revealed normal LV and right ventricular function with signs of concentric LV remodeling and no regional wall motion abnormality. Cardiac MRI was performed on March 24, 2020 for evaluation of possible inflammatory myocardial injury. Because of dyspnea, the cardiac MRI (Philips 1.5 Tesla) examination was performed during free breathing using mostly single-shot sequences. Normal LV and right ventricular function and no regional wall motion abnormalities were noted (Figure 1b, Video 1−Cine single-shot 3-dimensional balanced turbo-field-echo sequence—4 chamber view). No focal fibrosis was detected in late gadolinium enhancement sequences (Figure 1c, single-shot inversion recovery sequence—4 chamber view). Global edema in T2 weighted images was visible (Figure 1d, T2 [short tau inversion recovery] sequence—3 chamber view) as well as globally elevated T2 (56 ms, referent 48 $\pm$ 3 ms) (Figure 1e, T2 mapping—short-axis view) and T1 (1,090 ms, referent 989 $\pm$ 28 ms) (Figure 1f, T1 mapping—short-axis view) mapping times, suggesting acute myocardial injury. On March 26, 2020, hypoxic respiratory failure (saturation of 80%) required mechanical ventilation. The patient improved and was extubated, and the level of cardiac biomarkers declined (N-terminal proB-type natriuretic peptide 631 ng/liter, troponin 61 ng/liter) in due course.

Cardiac MRI with its unique accuracy in defining cardiac morphology and function and its ability to provide tissue characterization makes it well suited to study cardiac involvement in COVID-19. Recently, Inciardi et al[3] proved severe biventricular myocardial injury with edema and late gadolinium enhancement. In the absence of epicardial coronary artery stenosis, sub-clinical myocardial dysfunction in COVID-19 may be a consequence of an impairment of microcirculatory endothelial function observed during the early stages of the systemic inflammatory response to the infection, which portends a poor prognosis in patients with established cardiovascular disease and impaired microcirculatory endothelial function.[4] In addition, direct COVID-19–mediated infection of endothelial cells might contribute to cardiac injury.[5]

In summary, we show that elevated biomarkers of cardiac injury were associated with generalized myocardial edema without late gadolinium enhancement in cardiac MRI despite a normal echocardiogram during COVID-19.

Supplementary materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.healun.2020.04.025.

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COVID-19 in a pediatric heart transplant recipient: Emergence of donor-specific antibodies

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Early reports have suggested that severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) associated coronavirus disease 2019 (COVID-19) generally causes mild disease in children.[1] Pediatric solid organ transplant recipients are generally more susceptible to viral respiratory infections and have increased morbidity and mortality.[2] There have been limited reports of COVID-19 disease in heart transplant recipients.[3]

A 3-year-old female child underwent orthotopic heart transplantation at 11 months of age for congenital dilated cardiomyopathy in late 2017. Her post-transplant course had been unremarkable, except for persistent Ebstein Barr virus (EBV) viremia, for which the intensity of immunosuppression had been reduced to tacrolimus monotherapy. In the first week of March 2020, the patient developed a productive cough with rhinorrhea and nasal congestion. She was afebrile with no symptoms of shortness of breath. One month before this illness, she was treated for febrile bronchiolitis as an outpatient. The potential for COVID-19 was considered, but community incidence was low at the time. The patient had no Centers for Disease Control risk factors for infection, and testing

was not widely available. One week later, a follow-up telehealth visit was performed with improvement in the severity of cough, and she remained afebrile. Surveillance laboratory studies including complete blood count, EBV whole blood DNA, and anti-human leukocyte antigen antibody testing by Luminex assay happened to be performed at that time. The patient was noted to have baseline leukopenia of $4.73 \times 10^3/\mu l$, stable tacrolimus trough of 4.9 ng/ml, and the following de novo Class II donor-specific antibodies: DQ4 (strong mean fluorescent intensity [MFI] 10110), DR8 (moderate MFI 3,389), and DQA1*04 (weak MFI 3,458). The patient was scheduled for admission to administer intravenous immunoglobulin one week after the laboratory studies were obtained. Because of the history of cough, our patient immediately underwent SARS-CoV-2 RNA nasal swab reverse transcriptase polymerase chain reaction testing and was placed under enhanced droplet precautions. Admission vitals were notable for axillary temperature of 36.4˚C, heart rate of 123 beats per minute, respiratory rate of 24 breaths per minute, and systemic oxygen saturation of 96%. Examination was notable for intermittent wet cough but with no increased work of breathing and clear breath sounds on auscultation. Overnight, the patient tolerated administration of 0.5 g/kg of intravenous immunoglobulin (IVIG) without complication. The SARS-CoV-2 reverse transcriptase polymerase chain reaction test returned positive the following morning. The patient remained well, appearing without symptoms of respiratory distress, and vital signs remained unchanged. Given the history of symptoms beginning 2–3 weeks before admission and clinical stability, further testing and evaluation were deferred, and the patient was eventually discharged. Repeat SARS-CoV-2 nasal polymerase chain reaction was planned for 2 weeks with repeat anti–human leukocyte antibody testing, and IVIG administration was repeated every month for 2 more months.

Notably, this patient was receiving tacrolimus monotherapy at the time of infection because of persistent EBV viremia and, therefore, may have mounted a more efficient immune response than if she had additionally been receiving an anti-metabolite or corticosteroid. In vitro data suggest inhibition of viral replication of human coronaviruses by FK-506.[4] Interestingly, de novo donor-specific Class II antibodies were also detected during the infection. Allosensitization after viral infections is described, and because of reduced immunosuppression, our patient may have been prone to this phenomenon.[5] This patient tolerated IVIG administration with concurrent COVID-19 infection without any notable reaction. We would be hesitant to attempt more aggressive forms of desensitization with active infection until more clinical knowledge of COVID-19 infection is available. Although mechanisms and relationship between allosensitization and COVID-19 remain uncertain, we suggest that careful measurement of donor-specific antibodies be undertaken in heart transplant survivors of this infection.

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