

## Acute Myocardial Infarction in a 9-Year-Old Boy Due to Multisystem Inflammatory Syndrome

### INTRODUCTION

Myocardial infarction (MI) is extremely rare in children after coronavirus disease-2019 (COVID-19) exposure, unlike in adults.<sup>1,2</sup> The case of a pediatric patient who presented with MI is described herein. In the literature review that was conducted, no studies could be found that described MI due to total occlusion of the main coronary artery caused by multisystem inflammatory syndrome in children (MIS-C).

### CASE REPORT

A 9-year-old boy presented to the emergency department with 1-day duration of acute-onset chest pain. Other symptoms included nausea and mild abdominal pain. There was no familial history and no previous history of cardiovascular disease, other medications, or illegal drug abuse. He was previously fully healthy.

His general condition was stable with an initial normotensive value of 117/74 mm Hg, heart rate of 98 beats per minute, and normal oxygen saturation in room air. His body weight was 25 kg (10<sup>th</sup>-25<sup>th</sup> percentile). Capillary refill time was <3 seconds. Diuresis was normal. He had no dyspnea, rash, conjunctivitis, extremity edema, or lymphadenopathy.

The findings of his general physical examination were normal, except for a short systolic murmur in the cardiac apex. He had an elevated body temperature of 38.1°C, which was slightly increased to 38.6°C in follow-up, with persistent fever lasting for 5 days.

Electrocardiography (ECG) showed widespread ST-segment changes with definite elevation on the extremity derivatives (DI, DII, DIII, and aVF) and marked ST depression on the chest derivatives (V1-V6) and aVR and aVL, signifying lateral inferior ischemia (Figure 1). Chest radiography was normal.

The blood work-up revealed a high troponin I level of 24 909 ng/L [normal limits (NL): 12-20], high D-dimer (1.27 mg FEU/mL; NL: <0.5), and high serum prohormone B-type natriuretic peptide (pro-BNP; 3266.5 pg/mL; NL: <300). In blood gas evaluation, the lactate level was slightly elevated at 22.73 mg/dL (NL: 4.5-19.8). White blood cell count, acute phase reactants (C-reactive protein level), and liver function tests were also elevated at 16.67 × 10<sup>3</sup>/mL (NL: 4.5-13.5), 8.23 mg/L (NL: <5), aspartate aminotransferase of 559 U/L (NL: <47), and alanine aminotransferase of 76 U/L (NL: <39). Ferritin was elevated at 346 ng/mL (NL: 14-124) and the fibrinogen level was also high at 637 mg/dL (NL: 170-400). Erythrocyte sedimentation rate was 47 mm/h (NL: 0-13). Leukocytosis showed a neutrophilic dominance of 14 230/mL with lymphopenia at 1020/mL.

The patient's polymerase chain reaction test for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was negative, but the total antibody level was determined to be 5.33 U/mL and positive.

Transthoracic echocardiography revealed left ventricular systolic dysfunction and global wall hypokinesia with a left ventricular ejection fraction of

### CASE REPORT



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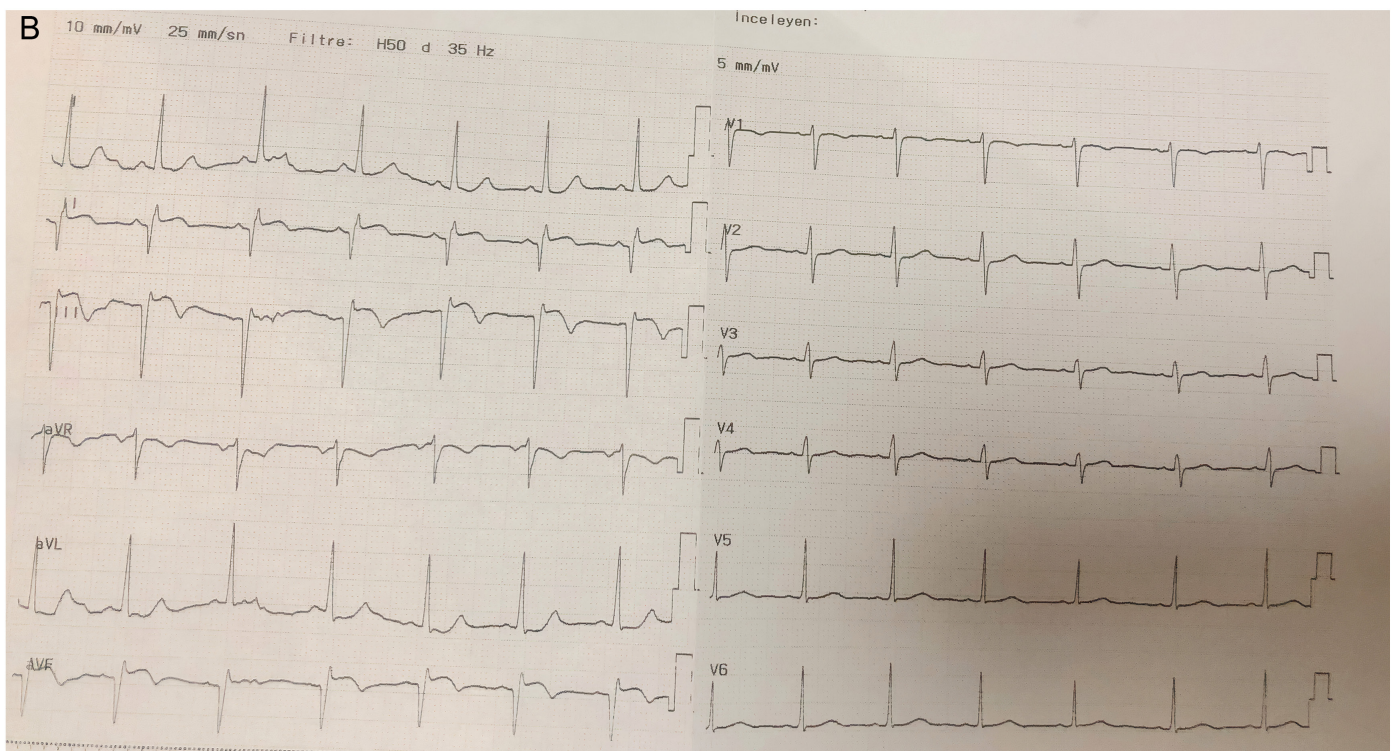
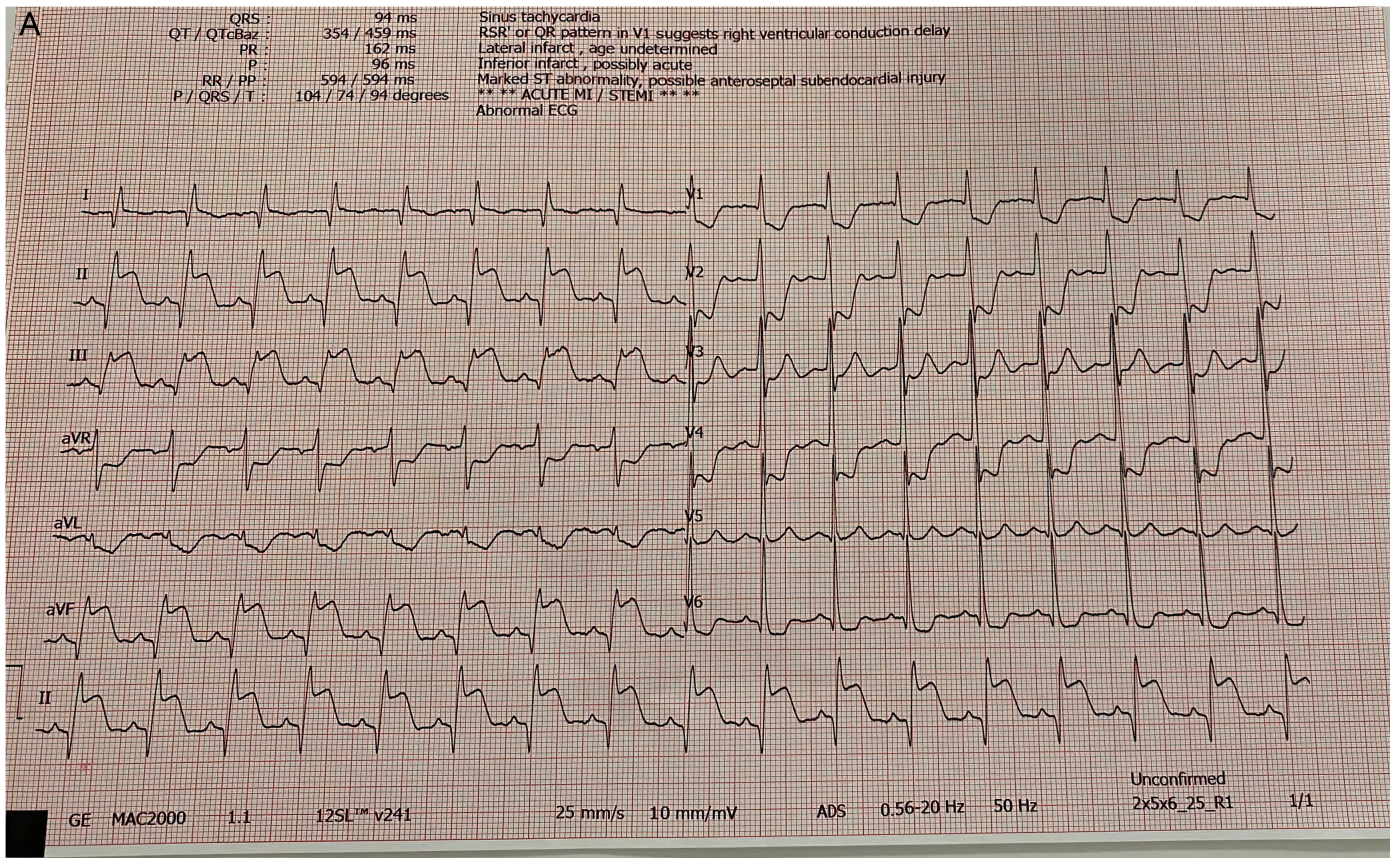
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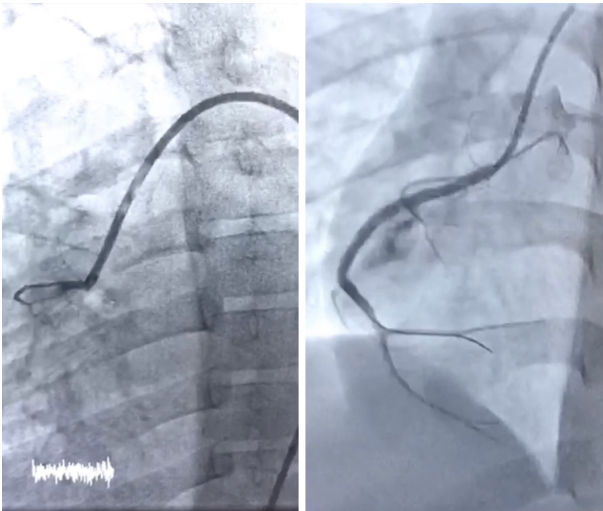
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**Figure 1. A. Lateral inferior myocardial infarction findings on ECG. B. ECG findings at discharge. ECG, electrocardiogram.**

45%-50% and mild mitral regurgitation (Video 1). There was no coronary artery dilatation or aneurysm or other origin abnormalities.

Due to the existence of fever with 2-body system involvement (cardiac, gastrointestinal), CRP rise, and prior SARS-CoV-2 exposure in a month, a diagnosis of MIS-C was made.



**Figure 2. Right main coronary artery angiographic findings before and after stent replacement.**

A single dose of intravenous immunoglobulin (IVIg) of 2 g/kg and dexamethasone at 2 mg/kg/day were administered with enoxaparin (2 × 1 mg/kg/dose) and acetylsalicylic acid (ASA; 5 mg/kg/day). Troponin levels continued to rise (>24 909 ng/L, NL: 12-20), and ischemia findings were still observed by ECG. Because of the possibility of MI, it was planned to visualize the coronary arteries by angiography.

On coronary angiography, total occlusion of the right coronary artery (RCA) was detected (Figure 2, Video 2). The left coronary artery was patent (Video 3). Two drug-covered stents (Evermine50, 2.75 × 16 mm, and Promus Premier, 2.5 × 32 mm; Boston Scientific, Natick, Massachusetts, USA) were implanted into the proximal and distal part of the RCA. One dose of IV heparin was given after stent replacement. No major complications occurred (Figure 2, Video 4). After the procedure, clopidogrel (1 mg/kg/day) was added to ASA.

Results for other-related causes of MI, including lipid profiles [low-density lipoprotein (LDL), high-density lipoprotein (HDL), very-low-density lipoprotein (VLDL), triglycerides], lipid electrophoresis, thrombophilia testing, antinuclear antibodies, anti-double-stranded DNA, c-ANCA, and p-ANCA, were all normal. Thrombophilia testing affirmed normal protein C, protein S, homocysteine, vitamin B12, and antithrombin III levels, with negative results for prothrombin mutation and lupus anticoagulant. The results for β<sub>2</sub>-glycoprotein, anticardiolipin antibodies, and factor V Leiden mutation were all negative. Plasminogen activator inhibitor-1 (PAI-1) 4G/5G homozygote mutation was positive.

In the follow-up ECG results, deep Q waves were observed in leads D2, D3, and aVF, but the ST segment was normal (Figure 1).

## DISCUSSION

ST-elevation MI is very rare in children and even in adolescents without underlying heart disease. The COVID-19 pandemic that has occurred as a result of SARS-CoV-2 could be an important risk factor for hypercoagulability and MI in

adults.<sup>3</sup> Although it seemed to be very rare in children at the beginning of the pandemic, it was later seen that COVID-19-related syndromes such as MIS-C could affect the coronary arteries in children, similarly to Kawasaki syndrome.<sup>4</sup> On the other hand, recent studies in adults on post-COVID-19 syndrome have explained the late effects of thromboembolism, even if the patient had no other signs of inflammation.<sup>5</sup>

To our knowledge, this is the first reported case of total RCA occlusion and stent implantation in such a young patient after COVID-19 exposure.

Considering the patient's recent exposure to COVID-19, the decreased left ventricular function, high cardiac enzyme levels, and ECG findings of this case were initially suggestive of myopericarditis due to acute COVID-19 and/or MIS-C. While it was difficult to confirm a final diagnosis, essential therapy with IVIg and steroids was begun. Until reviewing the ECG findings, including both ST elevation and ST depression on reciprocal leads, it was thought that the patient had MI rather than myopericarditis. ST depression is generally not expected in cases of myopericarditis; on the contrary, a diffusely evolving ST elevation is assumed.<sup>6</sup> Other factors that helped us distinguish this case from non-ischemic causes were the extreme elevations of troponin and pro-BNP levels.

Both acute COVID-19 infection and MIS-C may lead to thrombosis and coronary artery aneurysms with proinflammatory cytokines and induction of procoagulant factors, leading to hemodynamic changes that increase the risk of atherosclerotic plaque rupture and resulting in acute MI in adults.<sup>7</sup> Thromboembolism may also complicate the post-COVID period in the context of a hypercoagulable state.<sup>5</sup> Virchow's triad comprises vascular damage, altered blood flow, and hypercoagulability of the blood.<sup>8</sup> These factors could be related to venous thrombosis and myocardial infarction.<sup>9</sup>

Differentiating between acute COVID-19 and MIS-C is important because of their dissimilar therapy options and this can be challenging under some conditions.<sup>10</sup> Because of the pandemic and other related history and clinical factors including recent exposure to COVID-19, elevated acute phase reactants, cardiac markers (troponin I and pro-BNP), fever, and the involvement of more than one body system (gastrointestinal and cardiovascular), MIS-C was determined to be the prominent cause of this case. The criteria of the Centers for Disease Control and Prevention were confirmed for this patient.<sup>11</sup> As the patient had a negative test for COVID-19 and the absence of lung involvement, it was concluded that this was not a case of acute COVID-19.

There have been questions about whether thrombosis in cases of COVID-19 could be a result of thrombophilia susceptibility. Some studies have suggested performing analysis for other thrombophilia factors,<sup>12</sup> whereas some studies did not find a significant relationship between the positivity of genetic thrombotic factors and the severity of COVID-19 infection.<sup>13</sup> Although the PAI-1 4G/5G promoter homozygote mutation was positive in the present case,

a relationship between this mutation and acute coronary artery thrombosis could not be found in previous adult studies, except in cases involving comorbidities such as metabolic syndrome with insulin resistance, obesity, and/or hyperlipidemia.<sup>14</sup> Our patient did not have obesity or hyperlipidemia. To date, no other case has been reported of this combination of MI and this particular mutation in the pediatric population.

Searching the literature, only 1 report of a patient presenting with thrombosis of the coronary arteries in MIS-C was identified.<sup>15</sup> Different from the current case, there was aneurysmal dilatation, the thrombosis occurred in the left anterior descending artery without total occlusion, and the case was treated by fibrinolytic therapy. Another similar case was reported for a patient with acute COVID-19<sup>2</sup> and that patient also did not have a stent implanted, as it occurred in the distal ramus branch of the left coronary artery.

Stent implantation is very rare in children.<sup>16</sup> As the main coronary artery's total occlusion was significant in the present case, it was decided to implant a stent.

## CONCLUSION

This case entailed a very rare complication due to MIS-C in a very young patient without underlying comorbidities that would make him prone to coronary artery thrombosis. Fast angiographic intervention is necessary in such cases following anticoagulant therapy.

**Informed Consent:** An informed consent was obtained from the patient's family for publication of this case report and any accompanying images.

**Video 1:** Left ventricular systolic dysfunction and global wall hypokinesia in the echocardiography.

**Video 2:** Total occlusion of the right main coronary artery in the angiography.

**Video 3:** Left coronary artery in the angiography.

**Video 4:** Stent position and complete recovery of the obstruction.

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