Case Report

Suspected subclinical myocarditis detected by cardiac magnetic resonance imaging late post COVID-19 recovery

Nilesh R. Ghugre (PhD)\textsuperscript{a,b,c}, Ady Orbach (MD)\textsuperscript{a}, Labonny Biswas (BSc)\textsuperscript{a}, Kim A. Connelly (MD, PhD)\textsuperscript{a}, Adrienne Chan (MD)\textsuperscript{e}, Bradley H. Strauss (MD, PhD)\textsuperscript{a}, Graham A. Wright (PhD)\textsuperscript{a,b,c}, Idan Roifman (MD)\textsuperscript{a,}\textsuperscript{*}

\textsuperscript{a}Schulich Heart Program, Sunnybrook Health Sciences Centre, Toronto, ON, Canada
\textsuperscript{b}Department of Medical Biophysics, University of Toronto, Toronto, ON, Canada
\textsuperscript{c}Division of Cardiology, St. Michael’s Hospital, Toronto, ON, Canada
\textsuperscript{e}Division of Infectious Diseases, Sunnybrook Health Sciences Centre, Toronto, ON, Canada

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A B S T R A C T

There is growing evidence of the potential for cardiac involvement in patients who have been infected with COVID-19. In this case study, we present a patient with no history of cardiovascular disease, who was hospitalized for COVID-19 pneumonia and subsequently recovered. Despite normal serum troponin levels and left ventricular structure and function, multi-parametric cardiac magnetic resonance imaging revealed a classic myocarditis-like pattern of injury approximately 6 months after his convalescence. Physicians should be aware of the possibility of late myocardial injury/inflammation in patients with recovered COVID-19, even in the absence of elevated troponin levels and/or left ventricular dysfunction.

Learning objective: To understand the potential for COVID-19 patients to develop myocardial injury. To recognize that myocarditis can occur in patients with resolved COVID-19 infection months after resolution of the infection and in the absence of left ventricular dysfunction and troponin elevation.

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Introduction

Prior case series have described the potential for cardiac involvement in patients who are actively infected with COVID-19. In this case report, we report a case of late suspected subclinical myocarditis approximately 6 months after resolution of active COVID-19 infection that was detected by cardiac magnetic resonance despite normal serum troponin levels and normal left ventricular function.

Case report

A 62-year-old male patient was admitted to our hospital due to coronavirus disease-19 (COVID-19) pneumonia. Prior to his hospitalization, he returned from a business trip to the Dominican Republic, where he was exposed to a known COVID-19 positive patient. Upon his return to Canada, he developed symptoms of lethargy, fatigue, headache, productive cough, and fever followed by dyspnea and tachypnea. His initial physical examination at the emergency department revealed a heart rate of 90 beats per minute, blood pressure of 133/76 mmHg, a mild fever, measured at 38.1 °C orally, and oxygen saturation of 95% that rapidly fell to 90% with minimal movement.

Past medical history. The patient had a past medical history consisting of hypertension and dyslipidemia, but there was no history of cardiovascular disease or myocarditis.

Investigations. During initial investigations in the emergency department, the patient tested positive for COVID-19 via polymerase chain reaction nasopharyngeal swabbing. On initial blood work, there was lymphopenia (0.7 × 10\textsuperscript{3}/L), mild respiratory alkalosis (pH 7.55, pCO\textsubscript{2} 26 mmHg, bicarbonate 23 mmol/L), and a high-sensitivity troponin of 12 ng/L (lower than the 99th percentile upper reference limit value at our hospital of 15 ng/L). The initial troponin was checked on the first day of admission. A subsequent serum troponin, checked five days later, was also 12 ng/L. After this second serum troponin test, there were no further troponin measurements performed on this patient. The serum creatine kinase (CK) peaked at 426 U/L (normal at our institution is <195 U/L). CK-MB is no longer performed in our jurisdiction.

\* Corresponding author.
E-mail address: idan.roifman@sunnybrook.ca (I. Roifman).

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having been replaced by high-sensitivity troponin assays. Electrocardiogram showed normal sinus rhythm with no significant ST-T wave abnormalities. Chest X-ray showed patchy bilateral airspace opacities with a bronchovascular distribution suspicious for multifocal pneumonia. Computed tomography (CT) of the chest was not performed.

Management. The patient was treated with ceftriaxone for suspected bacterial superinfection with subsequent clinical improvement. He had no manifest cardiac symptoms while in hospital. He had mild shortness of breath but no orthopnea or paroxysmal nocturnal dyspnea, no chest pain, palpitations, syncope, or presyncope. He did not have arrhythmias on telemetry monitoring. He was discharged home approximately one week after admission for further follow-up and self-isolation. After discharge, his symptoms almost completely resolved, and he was cleared to discontinue his home isolation approximately two weeks after his diagnosis. Despite maintaining an active lifestyle post recovery, the patient complained of a mild subjective reduction in his exercise capacity, which is ongoing at the time of writing. A cardiovascular magnetic resonance (cardiac MRI) examination was subsequently performed. It was performed on a 1.5T MRI scanner (MR450w, GE Healthcare, Toronto, Canada) approximately 6 months (181 days) after his first COVID-19 related hospital admission. The MRI protocol included routine cine imaging for the evaluation of cardiac structure and function and late gadolinium enhancement (LGE) imaging for the evaluation of scar. In addition, native T2 maps and, native and post-contrast T1 maps were acquired and processed to obtain myocardial T1, T2, and extracellular volume fraction (ECV) values. The MRI showed normal left ventricular (LV) size and function [LV end diastolic volume indexed to body surface area (BSA) was 61 ml/m²; LV ejection fraction was 62%; LV mass indexed to BSA was 47 g/m²] as well as normal right ventricular (RV) size and function (RV end diastolic volume indexed to BSA was 64 ml/m², RV ejection fraction was 59%). There were no regional wall motion abnormalities (see Videos 1–3). However, LGE imaging revealed an area of mid myocardial/subepicardial late enhancement in the basal inferolateral wall with a non-ischemic pattern, most consistent with a myocarditis type pattern (see Fig. 1). A gradient in T1, T2, and ECV values was noted moving from apical to basal slices with elevated values toward the base, associated with proximity to the LGE enhanced region (see Fig. 2). Our institutional normal (healthy) reference ranges (mean +/- standard deviation) for T2 and T1 are: T2 = 40 +/- 2 ms and T1 = 904 +/- 26 ms. Compared to these normal values, myocardial T2 and T1 relaxation values seen in our case study demonstrated only marginal elevation, although the basal sections demonstrated elevations in T2 (443 ms) and T1 (965.9 ms) that were just outside the 95% confidence interval of the normal range. Segmental analysis of the basal myocardium further revealed a high T2 value of 45.7 ms (relative to normal values) in the lateral myocardium associated with the LGE positive region. Overall, these measures were indicative of abnormal hyperintense MRI relaxation associated with the presence of edema. ECV values were noted to be within the limits of normal values observed in healthy subjects from prior studies [1]. While subclinical myocarditis was considered the most likely diagnosis, a number of other non-ischemic etiologies were also considered including cardiac sarcoidosis. However, the probability of this case representing cardiac sarcoidosis was believed by the clinical team to be very low given the fact that the chest X-ray was normal and did not reveal any signs of pulmonary sarcoidosis and given the fact that the LGE and T1/T2 mapping was more consistent with myocarditis due to the location of the abnormality and the lack of multiple areas of LGE positivity that often accompanies cardiac sarcoidosis. Furthermore, the MRI localizers which provide valuable imaging of the lungs and lymph nodes, did not reveal any signs of lymphadenopathy and/or pulmonary manifestations of sarcoidosis. CT of the chest, positron emission tomography-CT and myocardial biopsy were not performed. These investigations are rarely ordered in Canada when myocarditis is suspected and meets Lake Louise MRI criteria [2]. Furthermore, the possibility exists that other viruses known to be linked with the development of myocardial injury and myocarditis can lead to the same imaging findings found in our patient. However, with the exception of his COVID-19 infection, this patient did not have any other recent history of influenza or influenza like illness (ILI), colds, or other episodes where he had upper respiratory symptoms. In fact, he informed his clinical team that he has not
had a cold or ILL that he could remember for a number of years prior to the onset of his COVID-19 symptoms. Given all these factors, suspected subclinical myocarditis due to COVID-19 infection was deduced to be the most likely diagnosis.

**Discussion**

There have been a small number of studies that utilized cardiac MRI to demonstrate myocardial inflammation in COVID-19 patients. A study by Huang et al. in 26 COVID-19 patients reported abnormal MRI findings (edema and or LGE) in 58% of the patients [3]. Another recent study by Puntmann et al. reported that 71% of these patients demonstrated elevated troponin levels and 78% of them had abnormal MRI findings, including LGE (32%) and elevated T1 (71%) and T2 values (60%) [4].

Our case study is informative in two respects. First, despite having troponin levels within the normal range and despite the presence of normal LV function and the absence of regional wall motion abnormalities, our patient demonstrated a classic myocarditis-like MRI pattern – an inferolateral subepicardial/mid myocardial LGE lesion with abnormal T2 hyperintensity, thus satisfying the Lake Louise criteria for myocarditis [2]. This phenomenon is known to also occur with other non-COVID etiologies of myocarditis, with one paper reporting only 35–45% of cases with biopsy proven myocarditis had elevations in serum troponin [5].

Second, the fact that the abnormal MRI findings were detected approximately 6 months after clinical resolution of the COVID-19 infection suggests that the myocardial inflammation, apparently caused by COVID-19 in this case, may persist in the subacute and subclinical state for a prolonged period. While COVID-19 infection is the most likely cause of the pattern of MRI imaging described in this report, we do not have pre-COVID imaging for comparative purposes. Thus, we cannot ascertain with certainty that the observed imaging abnormalities were not present prior to this patient’s infection with COVID-19. Finally, the cause of the patient’s mild subjective reduction in exercise capacity is unknown. It may reflect a mild manifestation of ‘long COVID-19’ syndrome, of which myocardial injury and inflammation has been postulated to play a role [6].

**Follow-up**

This patient was counselled against performing strenuous exercise and is currently being followed at regular intervals for the development of symptoms and/or signs of heart failure. Further, we plan to perform a repeat cardiac MRI in approximately 6 months to re-evaluate left ventricular structure and function as well as myocardial tissue characteristics.

**Conclusions**

Physicians should be aware of the possibility of late myocardial injury and myocarditis in patients with recovered COVID-19, even in the absence of elevated troponin levels and/or left ventricular dysfunction.

**Declaration of Competing Interest**

Graham Wright receives research funding and support from GE Healthcare, Canada and HeartVista Inc. USA. The other authors have no conflicts to report.

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**Ethics**

Written informed consent was obtained from the patient included in this case study.

**Supplementary materials**

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jccase.2021.04.014.

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