

[CASE REPORT]

Course of Cardiac Magnetic Resonance Imaging Findings in Acute Myocarditis after COVID-19 mRNA Vaccination

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Abstract:

Myocarditis is being increasingly reported as a rare complication of coronavirus disease 2019 (COVID-19) mRNA vaccines. We herein report a case of myocarditis following COVID-19 mRNA vaccination in a man. Cardiac magnetic resonance imaging (CMRI) revealed an area of high signal intensity on short T1 inversion recovery (STIR) and late gadolinium enhancement (LGE), which are characteristic of myocarditis. Follow-up CMRI performed six months later revealed improvement in the myocardial edema and LGE findings. CMRI is a useful non-invasive imaging modality for making an initial diagnosis as well as for follow-up in cases of myocarditis after COVID-19 mRNA vaccination.

Key words: COVID-19 vaccine, myocarditis, cardiac magnetic resonance imaging (CMRI)

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Introduction

Previous studies have described several cases of myocarditis following coronavirus disease 2019 (COVID-19) mRNA vaccination. The patients in these reports invariably presented with chest pain, usually two to three days after their second dose of an mRNA vaccine. Various hypotheses have been proposed to explain the mechanism underlying the onset, including the molecular activity of mRNA vaccines, molecular mimicry between the spike protein of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and self-antigens, and patients' genetic background (1).

We herein report a case of myocarditis following COVID-19 mRNA vaccination. Previous reports have described the diagnostic value of cardiac magnetic resonance imaging (CMRI). In the present case, special attention was given to the CMRI findings at the patient's six-month follow-up evaluation.

Case Report

A 27-year-old man with no remarkable medical history presented to the hospital with chest and back pain radiating

to the neck. He had received his second dose of a COVID-19 mRNA vaccine (mRNA-1273) three days before the symptom onset. After his second dose, he experienced a fever on the same day, which resolved over the following 24 h. He had no history of smoking or consuming alcoholic beverages but had a brother with acute myocarditis.

In the emergency room, the patient's electrocardiogram (ECG) showed ST-segment elevation in all the inductions except aVR (Fig. 1). A physical examination revealed a body temperature of 36.1°C, heart rate of 50 beats per minute, blood pressure of 120/93 mmHg, and oxygen saturation of 99% on room air. Acute myocarditis was suspected, but emergency coronary angiography was performed to rule out acute coronary syndrome. Significant stenosis of the coronary arteries was denied, but a left ventriculogram revealed a mildly reduced ejection fraction with hypokinesis of the anterolateral wall region of the apex (Fig. 2). A blood analysis at the initial visit revealed myocardial damage (troponin T 0.687 ng/mL; creatine kinase (CK)-MB 10%) and systemic inflammatory findings (white blood cells 10,400/ μ L; C-reactive protein 4.16 mg/dL) (Table 1).

COVID-19 was ruled out by a polymerase chain reaction (PCR) panel, and chest X-ray showed mild cardiac enlargement (Fig. 3). Transthoracic echocardiography revealed an

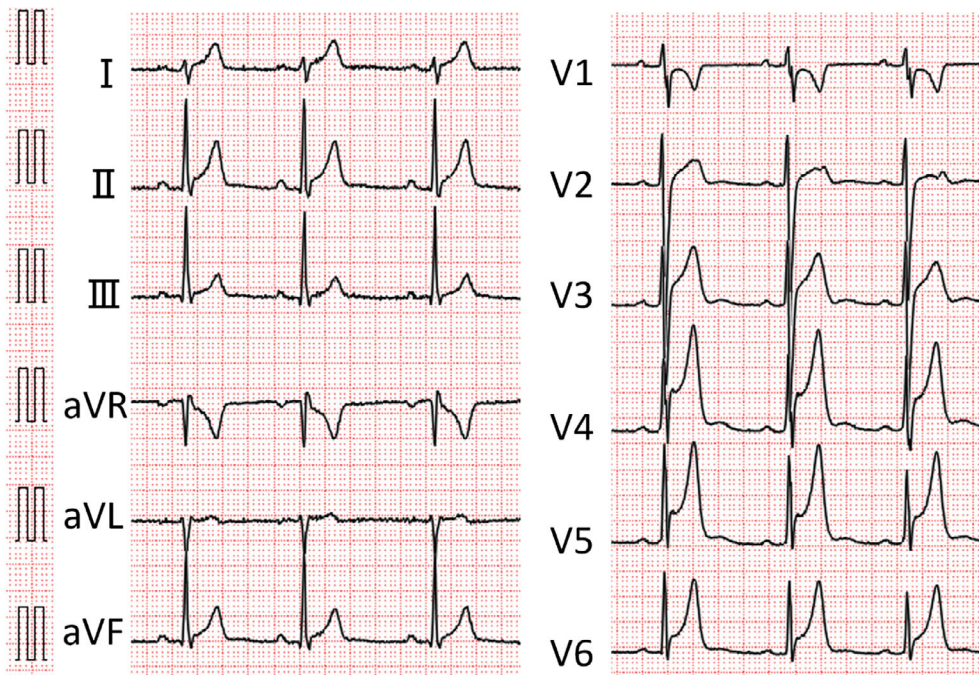


Figure 1. Electrocardiogram findings at presentation. ST-segment elevation was observed in all the inductions except aVR.



Figure 2. Coronary angiogram findings. There was no significant stenosis of the right coronary artery or left coronary artery.

estimated ejection fraction of about 55% with hypokinesia of the lateral wall region. A small amount of pericardial fluid was noted, but there was no significant valvular disease. CMRI revealed areas of high signal intensity on short T1 inversion recovery (STIR) and late gadolinium enhancement (LGE) of the anterolateral and inferolateral left ventricle, which are characteristic of myocarditis (Fig. 4). Paired antibody titers to various viruses to potentially identify the cause of the cardiomyopathy were negative (Table 2). Myocarditis after COVID-19 mRNA vaccination was finally diagnosed.

During follow-up without medical treatment, the CK peaked at 666 U/L, and the ST elevation showed improvement on an ECG. His subjective symptoms resolved by the next day, and he was discharged on day 8 of illness with a

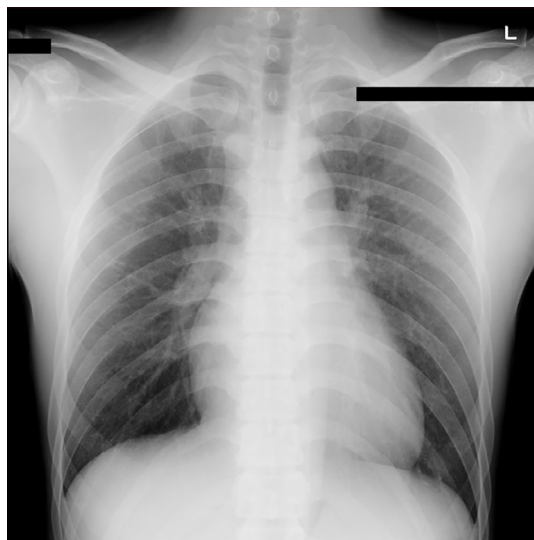
good prognosis. Because the local wall hypokinesia remained, beta blockers were administered as cardioprotective agents. At the six-month follow-up examination, the patient was completely asymptomatic, transthoracic echocardiography showed improvement in wall asynergy, and CMRI showed improvement in the STIR and LGE findings (Fig. 5).

Discussion

An important clinical finding of the present study was that CMRI is a useful non-invasive imaging modality for the diagnosis and follow-up of myocarditis after COVID-19 mRNA vaccination. CMRI is used to differentiate and assess the severity of cardiac diseases (2). Furthermore, the distri-

Table 1. Laboratory Data on Admission.

Peripheral blood		Blood urea nitrogen	13.1 mg/dL
WBC	10,400 / μ g	Serum creatinine	0.88 mg/dL
Neutrophils	83 %	Estimated glomerular filtration rate	87 mL/min/1.73 m ²
Eosinophils	2 %	Total protein	7.2 g/dL
Monocytes	6 %	Serum albumin	4.3 g/dL
Lymphocytes	9 %	Total bilirubin	1.5 mg/dL
Red blood cells	516 \times 10 ⁴ / μ g	Aspartate aminotransferase	51 IU/L
Hb	15.6 g/dL	Alanine aminotransferase	18 IU/L
Platelets	19.1 \times 10 ⁴ / μ L	Alkaline phosphatase	103 IU/L
Coagulation		Lactate dehydrogenase	236 IU/L
Activated partial thromboplastin time	25.6 s	Creatine kinase	519 IU/L
Prothrombin time	86.8 %	Creatine kinase MB	50 IU/L
D-dimer	0.9 μ g/dL	High-sensitive troponin T	0.687 ng/mL
Biochemistry		N-terminal prohormone of brain natriuretic peptide	177 pg/mL
Sodium	140 mEq/L	Hemoglobin A1c	5.2 %
Potassium	4.1 mEq/L	C-reactive protein	4.16 mg/dL
Chloride	105 mEq/L		

**Figure 3. Chest X-ray findings. Chest X-ray demonstrated mild cardiac enlargement.**

bution of LGE and myocardial edema can be used to assess disease severity (3). Almost all previous studies of myocarditis after COVID-19 mRNA vaccination have reported using CMRI to detect abnormalities suggestive of myocarditis, such as LGE or myocardial edema (4). Interestingly, in these reports, the distribution of myocardial edema and LGE on CMRI was mostly to the lateral wall, as also seen in other case series with adults and children (5-7). The present case also demonstrated the same distribution, which led to the diagnosis of myocarditis following COVID-19 mRNA vaccination. None of the previous reports examined the long-term course of the CMRI findings. In the present study,

CMRI was performed in the acute phase and at the six-month follow-up, with the latter revealing that the active myocarditis noted in the acute phase had resolved. No other abnormalities were found.

Myocardial LGE specifically reflects irreversible myocardial injury (i.e. necrosis and fibrosis) (8). The incidence of cardiovascular events in LGE-positive patients is considerably higher than in LGE-negative patients and plays an important role in predicting the prognosis (9). There are also reports that the gadolinium in LGE CMRI is associated with major adverse cardiovascular events in patients with acute myocarditis (10). Although there are reports of acute myocarditis in which the gadolinium later cleared (11), as in the present case, the mechanism by which the gadolinium is reduced or eliminated in post-acute myocarditis is unknown (12).

The CMRI findings in the present case suggested that myocarditis after COVID-19 mRNA vaccination is reversible. There are currently few reports of changes in CMRI findings over time in cases of myocarditis after COVID-19 mRNA vaccination. Further follow-up studies are therefore needed.

In conclusion, we reported a case of myocarditis following COVID-19 mRNA vaccination. CMRI was useful for diagnosing the disease and in the follow-up. Myocarditis following COVID-19 mRNA vaccination may be reversible. Currently, however, the pathomechanism of myocarditis after COVID-19 mRNA vaccination is still largely unknown, and further research is needed to understand what the long-term clinical outcomes are.

Informed consent was obtained from the patient.

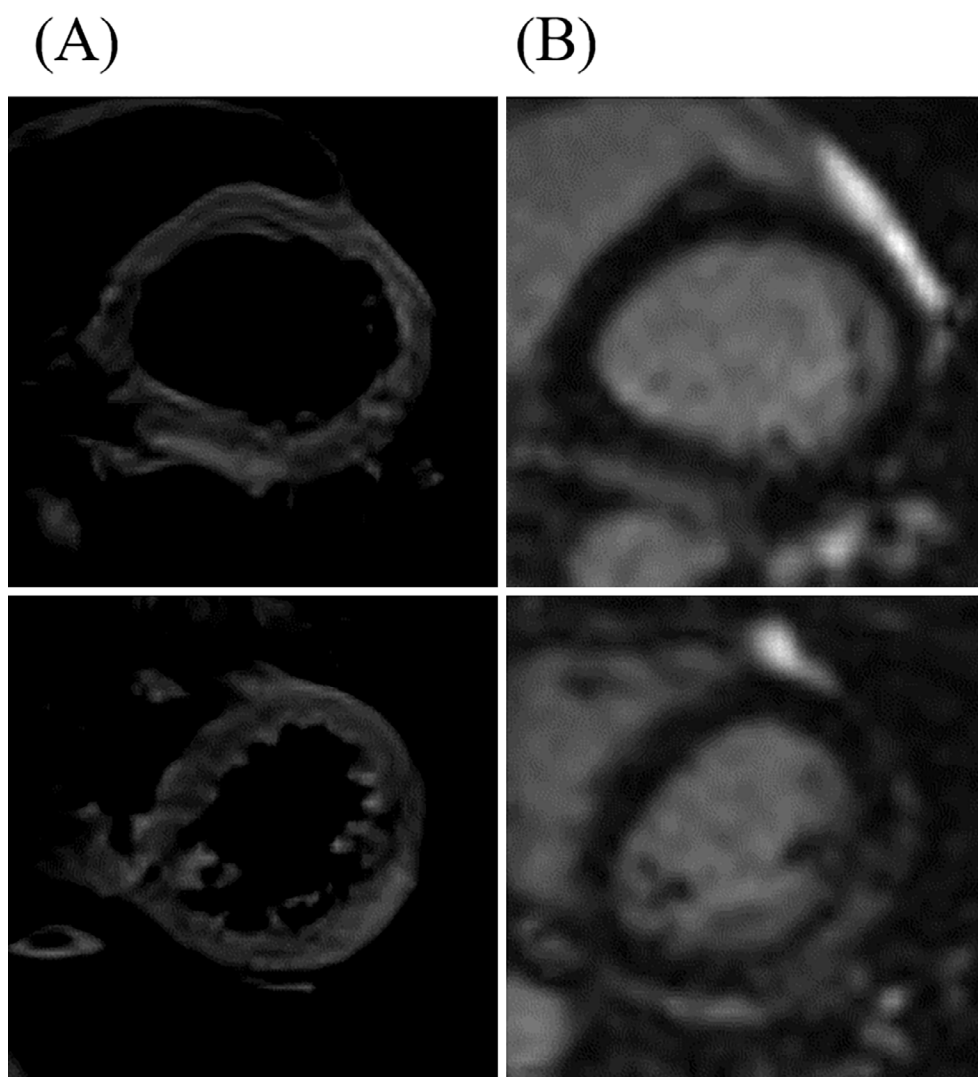


Figure 4. Cardiac magnetic resonance imaging findings on admission. Cardiac magnetic resonance imaging (CMRI) revealed areas of high signal intensity on short T1 inversion recovery (STIR) (A) and late gadolinium enhancement (LGE) (B) in the anterolateral and inferolateral left ventricle, which are characteristic findings of myocarditis.

Table 2. Paired Serum Examination.

	day1	day60		day1	day60
Influenza A	×16	×16	Coxsackievirus A		
Influenza B	×8	×8	Type 4	<4	×4
Adenovirus	×8	×8	Type 9	×32	×32
Human parvovirus B19	0.29	0.33	Type 16	×32	×64
Cytomegalovirus	×8	<4	Coxsackievirus B		
Human simplex virus	×32	×32	Type 1	<4	<4
Echovirus			Type 2	<4	<4
Type 9	×32	×32	Type 3	<4	<4
Type 11	×32	×32	Type 4	<4	<4
Type 14	<4	<4	Type 5	<4	<4
Type 16	<4	<4	Type 6	<4	<4
Type 22	×4	×4			

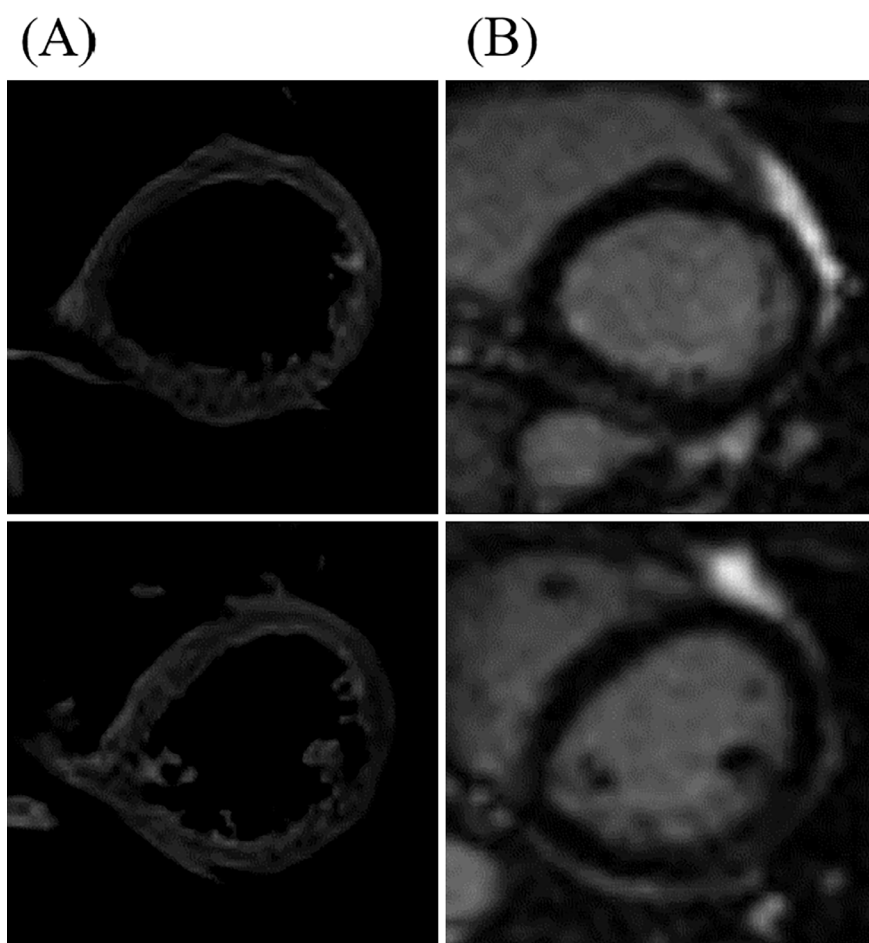


Figure 5. Cardiac magnetic resonance imaging findings at the six-month follow-up examination. Cardiac magnetic resonance imaging (CMRI) revealed that the areas of high signal intensity on STIR (A) and LGE (B) were no longer visible.

The authors state that they have no Conflict of Interest (COI).

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