Case Report

Cardiac magnetic resonance findings in acute myocarditis after mRNA COVID-19 vaccination

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There is increasing evidence for myocarditis as a complication of the mRNA coronavirus disease 2019 (COVID-19) vaccination. We report the case of a 20-year-old previously healthy man who presented with fever and chest pain 2 days after the second dose of mRNA-1273 vaccine. Electrocardiogram and laboratory studies showed extensive ST-segment elevation accompanied by elevated cardiac biomarkers. Cardiac magnetic resonance (CMR) revealed late gadolinium enhancement (LGE) characteristics of myocarditis. The patient rapidly improved with conservative management and was discharged on hospital day 6. As an advantage over previous reports, we performed a 1-month follow-up CMR. It showed improvement in myocardial edema but persistence of LGE which may indicate irreversible fibrosis. CMR may be useful not only for diagnosis but also for prognostic evaluation of myocarditis after COVID-19 mRNA vaccination. Learning objective: With the expansion of coronavirus disease 2019 (COVID-19) vaccine administration, the number of cases of myocarditis as a complication has been increasing. Cardiac magnetic resonance imaging can be useful for the diagnosis and follow-up of patients with myocarditis after mRNA COVID-19 vaccination. Persistent late gadolinium enhancement may indicate irreversible myocardial fibrosis, and it is also associated with poor prognosis, similar to previously reported cases of other acute myocarditis.

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Introduction

Coronavirus disease 2019 (COVID-19) has become a pandemic and affected millions of people since December 2019. With the development of novel mRNA based vaccines for COVID-19, a variety of possible vaccine-related adverse events have been reported [1]. Here, we report a case of mRNA-1273 (Moderna, Cambridge, MA, USA) vaccine-associated myocarditis in a previously healthy young man. Some previous reports showed the diagnostic value of cardiac magnetic resonance (CMR). In this case, we also had special attention to CMR findings of 1-month follow-up.

Case report

A previously healthy 20-year-old man presented to his primary physician with fever and chest pain 2 days after the second dose of mRNA-1273 vaccination. He had no history of recent viral illness or known COVID-19 exposure. His vital signs were stable, except for body temperature that indicated a high-grade fever (38.9 °C). Physical examination, chest radiography, and computed tomography images were normal. His electrocardiogram (ECG) showed extensive ST-segment elevation with PR-segment depression. Initial blood tests revealed that creatine kinase (CK) and CK-MB isoforms were within the normal range. High-sensitivity troponin T (0.104 ng/mL, normal range: <0.016 ng/mL), C-reactive protein (CRP) (19 mg/dL, normal range: <0.50 mg/dL), and white blood cell (WBC) (12,030/μL, normal range: 3,300–9,000/μL) were elevated. Acute myocarditis was suspected, and the patient was referred to our hospital the next day. ECG abnormalities remained unchanged (Fig. 1). His blood tests were remarkable with elevated cardiac and inflammatory markers with high-sensitivity troponin I (76.8 ng/L, normal range: <0.028 ng/L), CK (1,488 U/L, normal range: 60–250 U/L), CK-MB (99.7 U/L, normal range: <12 U/L), CRP (5.33 mg/dL, normal range: <0.50 mg/dL), and N-terminal pro-B-type natriuretic peptide (595 pg/mL, normal range: <125 pg/mL). Transthoracic echocardiography (TTE) showed a mildly reduced left ventricular ejection fraction (LVEF) of 42.4% with inferolateral hypokinesis and no significant valve disease. Coronary angiography revealed no obstructive coronary artery disease, and right heart catheterization revealed a preserved cardiac index (3.83 L/min/m² of body surface area) as measured by the thermo dilution method.)
As the COVID-19 outbreak has spread all over the world, mRNA vaccines have been approved for human use. The mRNA vaccines demonstrated excellent safety and clinical efficacy profiles in phase 3 clinical trials in adults [2,3]. Although no cases of myocarditis have been reported in clinical trials, with the expansion of vaccine administration, there are a growing number of reports of myocarditis after mRNA COVID-19 vaccination [1,4–6]. mRNA COVID-19 vaccination is associated with an elevated risk of myocarditis [1]. It predominantly occurs in young male adolescents within a few days after a second dose of vaccination [4]. While endomyocardial biopsy remains the confirmatory test in the diagnosis of myocarditis, it is an invasive test with risk of complications and carries the limitation of tissue sampling errors due to the focal nature of myocardial inflammation [7]. CMR is an established noninvasive modality for the diagnosis of myocarditis based on Lake Louise Criteria revised in 2018: increased myocardial signal intensity ratio or increased myocardial relaxation times or visible myocardial edema in T2-weighted images, increased myocardial relaxation times or extracellular volume fraction, or LGE in T1-weighted images [8]. The myocardial tissue characteristics observed in our patient were similar to those observed in acute viral myocarditis. CMR is considered useful for the diagnosis of COVID-19 mRNA vaccine-related myocarditis. The mainstay of management is supportive care, including arrhythmia management and treatment of heart failure [4]. Although some fatal cases have been reported [5], the clinical course is typically self-limited [4].

Herein, we report a patient with myocarditis after the administration of the mRNA COVID-19 vaccine. Our patient was a young man who had symptoms 2 days after the second dose of vaccination. He had typical symptoms, elevated biomarkers, and an ECG profile. Although the endomyocardial biopsy was negative, CMR led to the diagnosis of acute myocarditis. His LVEF was reduced after admission, but he developed no symptoms of heart failure and recovered within a few days.
Fig. 2. *Cardiac magnetic resonance images on the admission day.* Native T1-map (A) and T2-map (B) images in the short-axis view show a hyperintense signal in the anterolateral to inferolateral walls. Late gadolinium enhancement imaging in short-axis view (C) and four-chamber view (D) show subepicardial and mid-myocardial enhancement in the corresponding regions.

Fig. 3. *Cardiac magnetic resonance images at 1 month follow-up.* Native T1-map (A) and T2-map (B) images in the short-axis view reveal improvement of hyperintense signal in the anterolateral to inferolateral walls. Late gadolinium enhancement imaging in short-axis view (C) and four-chamber view (D) shows persistent subepicardial and mid-myocardial enhancement in the corresponding regions.
The clinical utility of CMR for the diagnosis of myopericarditis after the mRNA-1273 vaccine has also been reported [6]. As an advantage over previous reports, we performed a 1-month follow-up CMR in addition to acute-phase CMR. Follow-up CMR revealed persistent LGE, which may indicate irreversible fibrosis and association with worse prognosis in myopericarditis, even if left ventricular function and cardiac biomarkers are normalized [9,10]. The prognostic significance of these CMR findings in myopericarditis after COVID-19 mRNA vaccination is unknown at this time, and further follow-up is needed.

In conclusion, acute myocarditis should be considered in patients who present with chest pain or dyspnea within a few days of receiving mRNA COVID-19 vaccination, especially after the second dose. CMR may be useful for diagnosis and follow-up. Further studies are needed to elucidate long-term clinical outcomes.

Declaration of Competing Interest

The authors declare that there is no conflict of interest.

References

[1] Barda N, Dagan N, Ben-Shlomo Y, Kepten E, Waxman J, Ohana R, Hernan MA, Lipsitch M, Kohane I, Netzer D, Reis BY, Balicer RD. Safety of the BNT162b2 mRNA Covid-19 vaccine in a nationwide setting. N Engl J Med 2021;385:1078–90. doi:10.1056/NEJMoA2104075.

[2] Polack FP, Thomas SJ, Kitchin N, Absalon J, Gurtman A, Lockhart S, Perez JL, Marc GP, Moreira ED, Zerbini C, Bailey R, Swanson KA, Roychoudhury S, Koury K, Li P, et al. Safety and efficacy of the BNT162b2 mRNA Covid-19 vaccine. N Engl J Med 2020;383:2603–15. doi:10.1056/NEJMoa2034577.

[3] Baden LR, El Sahly HM, Essink B, Koteloff K, Frey S, Novak R, Diener L, Specter SA, Rouphael N, Creech CB, McGeechan J, Khateeb S, Segall N, Solis J, Brosz A, et al. Efficacy and safety of the mRNA-1273 SARS-CoV-2 vaccine. N Engl J Med 2021;384:403–16. doi:10.1056/NEJMoa2035389.

[4] Bozkurt B, Kamat I, Hotez PJ. Myocarditis with COVID-19 mRNA vaccines. Circulation 2021;144:471–84. doi:10.1161/CIRCULATIONAHA.121.056135.

[5] Verma AK, Lavine KJ, Lin CY. Myocarditis after Covid-19 mRNA vaccination. N Engl J Med 2021;385:1332–4. doi:10.1056/NEJMk1209975.

[6] Badshah M, Shriver AK, Lavine KJ, Sjovold A, Shaukat MHS, Rajpurohit N. MODERNa mRNA-1273 vaccine-associated myopericarditis in a patient with a subclinical autoimmune predisposition. J Cardiovasc Case 2021;24:227–9. doi:10.1016/j.jccase.2021.09.007.

[7] Anderson I, Pennell D. The role of endomyocardial biopsy in the management of cardiovascular disease: a scientific statement from the American Heart Association, the American College of Cardiology, and the European Society of Cardiology. Eur Heart J 2008;29:1696. doi:10.1093/eurheartj/ehn185.

[8] Ferreira VM, Schulz-Menger J, Holmwang G, Kramer CM, Carbone I, Sechtem U, Kindermann I, Gutterlet M, Cooper LT, Liu P, Friedrich MG. Cardiovascular magnetic resonance in nonischemic myocardial inflammation: expert recommendations. J Am Coll Cardiol 2018;72:1158–76. doi:10.1016/j.jacc.2018.09.072.

[9] Berg J, Kottwitz J, Baltensperger N, Kissel CK, Lovrinovic M, Mehra T, Scherff F, Schmied C, Tempelin C, Luscher TF, Heidecker B, Manka R. Cardiac magnetic resonance imaging in myocarditis reveals persistent disease activity despite normalization of cardiac enzymes and inflammatory parameters at 3-month follow-up. Circ Heart Fail 2017;10:e004262. doi:10.1161/CIRCHEARTFAILURE.117.004262.

[10] Gräni C, Eichhorn C, Bierre L, Murthy VL, Agarwal V, Kaneko K, Cuddy S, Aghayev A, Stegner M, Blankstein R, Jerosch-Herold M, Kwong RY. Prognostic value of cardiac magnetic resonance tissue characterization in risk stratiﬁng patients with suspected myocarditis. J Am Coll Cardiol 2017;70:1964–76. doi:10.1016/j.jacc.2017.08.050.