

Letter



Acute Myocarditis After COVID-19 Vaccination

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Conflict of Interest

The authors have no financial conflicts of interest.

A healthy 20-year-old man presented with chest pain one day after receiving the second dose of mRNA-1273 severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) vaccination (Moderna®) and came to the emergency room. He also received 1st coronavirus disease 2019 (COVID-19) vaccination which was the same vaccine 1 month before and had no side effects at that time. However, he experienced chest discomfort, nausea, and dyspnea on the night of 2nd injection. When the patient arrived at the emergency room, blood pressure was 107/74 mmHg, pulse rate 85/min, respiratory rate 20/min, body temperature 37.0°C, and peripheral oxygen saturation 96%. The electrocardiography showed the entire lead ST elevation except lead III. Blood tests revealed neutrophil dominant leukocytosis ($18.9 \times 10^3/\mu\text{L}$), elevated levels of cardiac markers such as creatine kinase MB (CK-MB), troponin I (TnI), N-terminal pro-brain natriuretic peptide (51.0 ng/mL, 5.12 ng/mL, and 752 pg/mL respectively) and elevated inflammatory marker C-reactive protein (CRP) level to 260.7 mg/L. The patient's COVID-19 polymerase chain reaction was negative. Also, enterovirus, adenovirus, and tests through other nasopharyngeal viral panels, and differential tests for parvovirus, human herpesvirus type 6, cytomegalovirus, and Epstein-Barr virus through serum were conducted when the patient admitted, and confirmed as all negative. Even though he was young, chest pain with ST-elevation on electrocardiogram and elevation of cardiac marker cannot rule out acute myocardial infarction, we urgently underwent coronary angiography and the result was negative.

On hospital day (HD) 2, the patient had mild dyspnea and fever up to 38.0°C with febrile symptoms, which were controlled with oxygen supply and intravenous paracetamol (Denogran®). Also, he had frequent ventricular premature complex (VPC) on tele-cardiac monitoring, so we prescribed carvedilol 3.125 mg twice daily. On laboratory tests, cardiac markers reached a peak level of 219.0 ng/mL (CK-MB) and 68.5 ng/mL (TnI). Transthoracic echocardiography showed severe hypokinesia of the whole left ventricle (LV) apex with preserved ejection fraction (50%) (**Figure 1A and B, Supplementary Videos 1 and 2**). On HD 4, cardiac magnetic resonance image (MRI) and endomyocardial biopsy (EMB) were performed at the right ventricular apex targeted to the interventricular septum. Cardiac MRI showed mid- and sub-epicardial band-like delayed hyperintense signals in the LV apex and interventricular septum (**Figure 2**). Interestingly, global strain image showed decreased LV apex strain at the location of hyperintense signal on cardiac MRI (**Figure 1C**). After a few days of supportive care with monitoring, his symptoms improved and cardiac markers were decreased to 2.8 ng/mL (CK-MB) and 0.43 ng/mL (TnI). Also, not only LV ejection fraction (58%), but also LV strain were normalized on echocardiography (**Figure 1D, E and F, Supplementary Videos 3 and 4**).

Author Contributions

Conceptualization: Lee S; Data curation: Cheon DY, Park MS, Kim DY; Investigation: Cheon DY, Jung MH, Choi JH; Project administration: Lee S; Supervision: Lee S, Han S, Ryu KH; Writing - original draft: Cheon DY; Writing - review & editing: Lee S.

On EMB and immunohistochemistry, a few inflammatory cells infiltration (**Figure 3A**) and focal positive of CD3+ and CD68+ cells, each representative of T lymphocyte and monocyte/macrophage cells, observed (**Figure 3B-D**). The patient was discharged on HD 7 with stable vital sign; blood pressure 120/80 mmHg, pulse rate 76, respiratory rate 20, body temperature 36.9°C and peripheral saturation was 99%. The patient returned to the outpatient department in two weeks later, and he was symptom-free and all cardiac and inflammatory markers such as CRP were normalized.

The reports of COVID-19 vaccine-related myocarditis with biopsy confirmation are limited in Korea.^{1,2)} A recent case study of clinically suspected acute myocarditis following mRNA COVID-19 vaccination reveals that it has a broad spectrum of histopathological features,³⁾ and two of thirds were lympho-dominant myocarditis. In our case, we performed cardiac MRI and EMB to confirm the diagnosis and revealed diffuse mononuclear infiltrates composed of CD68+ macrophages with CD3+ T lymphocytes, which is compatible with acute myocarditis. In this case, we concluded that T-cell and macrophage were expressed together and made myocarditis. A recently published article about SARS-CoV-2 reported similar findings that

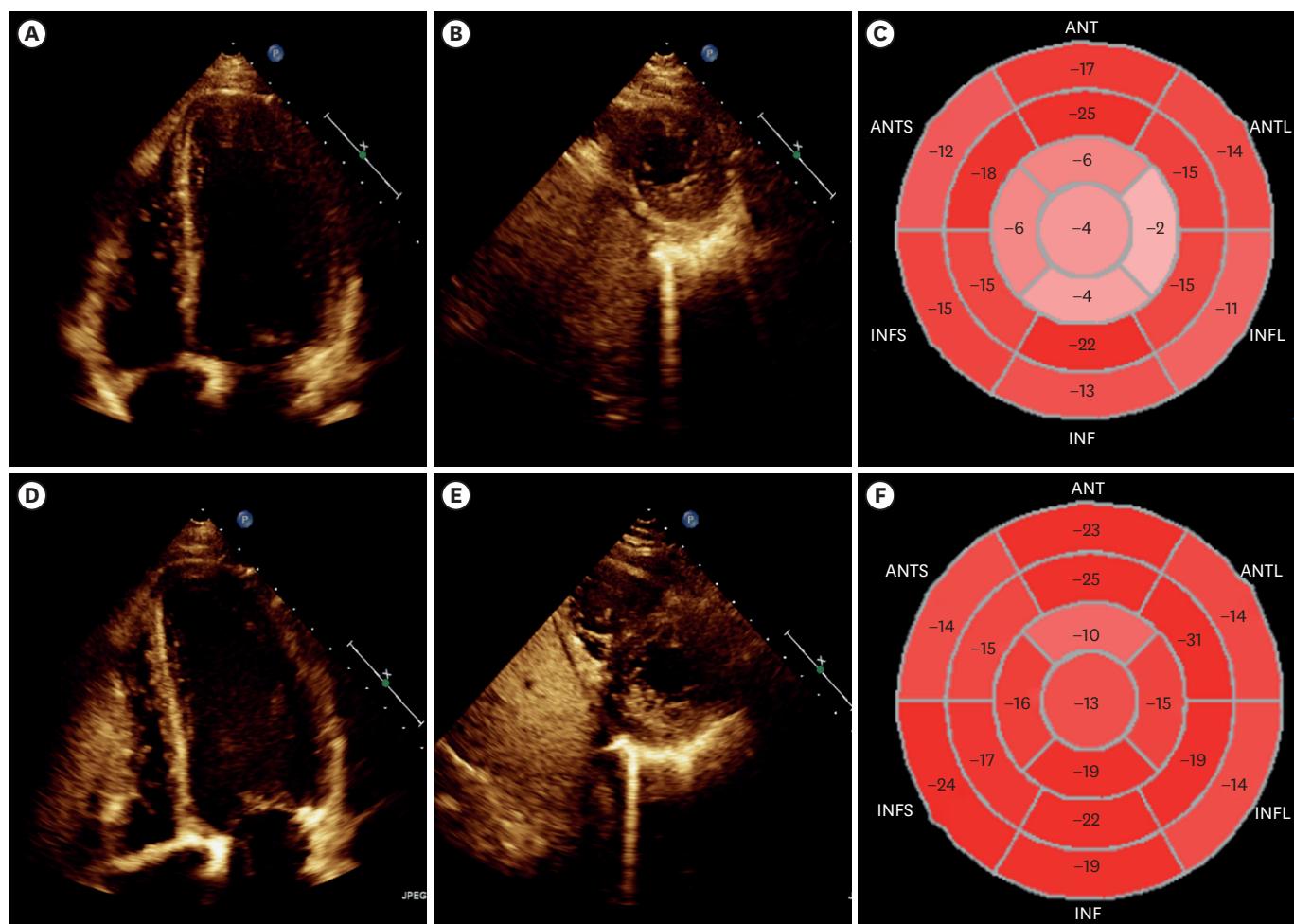


Figure 1. Echocardiography and LV global strain on hospital day 2 and 6.
(A, B) Severe hypokinesia of the whole LV apex was observed from initial TTE. (C) LV global strain image on same day (HD 2), which was a compatible finding of LV apical hypokinesia in TTE. (D, E) on HD 6, there is no more hypokinesia on TTE. (F) As same as TTE, LV strain was fully recovered.
LV = left ventricle; TTE = transthoracic echocardiogram; HD = hospital day.

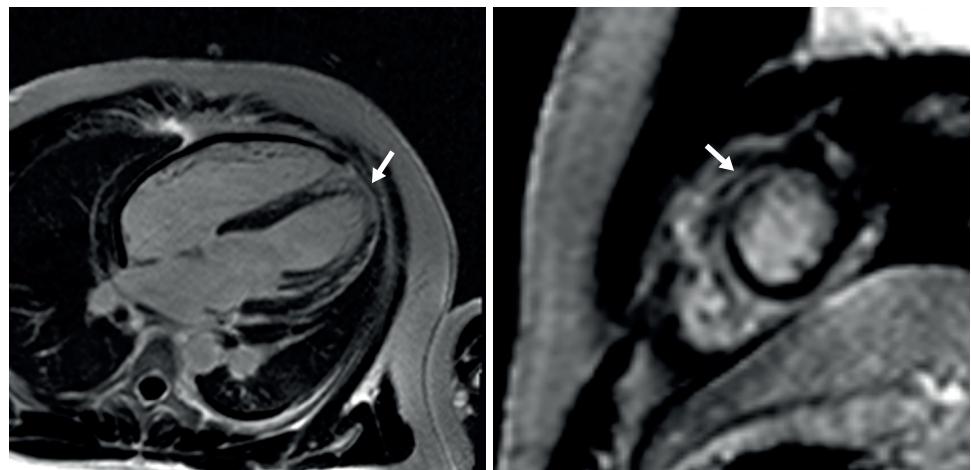


Figure 2. Cardiac MRI revealed mid- and sub epicardial band-like delayed enhancement in LV apical walls and interventricular septum (white arrow).
MRI = magnetic resonance image; LV = left ventricle.

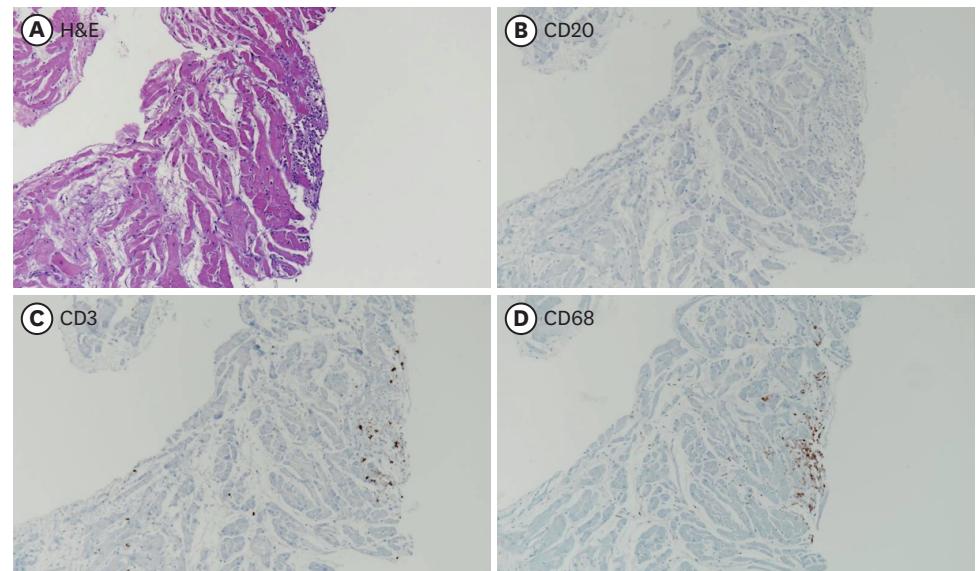


Figure 3. Endomyocardial biopsy.
(A) H&E stain, A few of inflammatory cell infiltration was found. (B) CD20+ stain which representative marker of B-lymphocyte, was not appear in histology. (C, D) CD3+ & CD68+ stain, suggests lymphocyte and monocyte/macrophage cells, were focal positive in myocardium.
H&E = hematoxylin and eosin.

macrophage and T cells including SARS-COV-2 generate positive feedback to each other and cause persistent inflammation in the lungs.⁴⁾ Although the thesis is related to the lungs and not heart, this case will serve as an example that acute myocarditis after COVID-19 vaccination can occur with a mechanism similar to that of the lungs. Our finding emphasizes the importance of EMB in suspected vaccine-related myocarditis to establish a correct diagnosis. Written informed consent was obtained from the patient.

SUPPLEMENTARY MATERIALS

Supplementary Video 1

Initial transthoracic echocardiography of apical 4 chamber view

[Click here to view](#)

Supplementary Video 2

Initial ransthoracic echocardiography of parasternal short-axis view

[Click here to view](#)

Supplementary Video 3

Follow up transthoracic echocardiography of apical 4 chamber view

[Click here to view](#)

Supplementary Video 4

Follow up transthoracic echocardiography of parasternal short-axis view

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