Early recurrence of myocarditis with atrioventricular block while wearing a wearable cardioverter-defibrillator after fulminant myocarditis: A case report

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Introduction

Myocarditis is an inflammatory disease of the myocardium that results from mononuclear cell infiltration and myocellular necrosis.[1] Fulminant myocarditis (FM) is acute myocarditis characterized by a rapid and severe decline in cardiac function with a high mortality rate. Different types of arrhythmias, including complete atrioventricular (AV) block, ventricular tachycardia (VT), and ventricular fibrillation (VF), and sudden cardiac death (SCD), occur during the acute stage of FM.[2] Most patients with FM require mechanical circulatory support to maintain end-organ perfusion until recovery.[3] If patients with FM can survive the acute phase crisis, they have improved cardiac function and favorable long-term survival rates, regardless of whether mechanical support is used.[4] However, in some patients, severe inflammation can lead to irreversible myocardial damage that prevents recovery of cardiac function and may require a left ventricular assist device or a heart transplant.[2] Moreover, cases of repetitive or recurrent myocardial inflammation after an obvious initial episode of myocarditis have been reported.[5] A wearable cardioverter-defibrillator (WCD) may prevent SCD during the most vulnerable period after the diagnosis of myocarditis.[6]

Here, we report a case of early recurrence of myocarditis with complete heart block with ventricular standstill and intermittently complete AV block while wearing a WCD after FM.

KEY TEACHING POINTS

- Repetitive or recurrent myocardial inflammation may occur after an obvious initial episode of myocarditis.
- A wearable cardioverter-defibrillator (WCD) may prevent sudden cardiac death (SCD) during the most vulnerable period after diagnosis of myocarditis. Aggressive use of WCD may be considered when the risk of SCD is especially high, such as in cases where ejection fraction has not fully returned or where there is late gadolinium enhancement in the cardiac magnetic resonance.
- If ventricular tachycardia or ventricular fibrillation is detected while wearing a WCD, the WCD can deliver shocks. However, cardiac arrest occurring while wearing a WCD can be recorded but not treated.

Case report

A 54-year-old man was asymptomatic but was noted to have an electrocardiogram (ECG) abnormality (details unknown) during a physical examination 2 years ago. Echocardiography showed a reduced left ventricular ejection fraction (LVEF, 43%) and enlarged left ventricular end-diastolic dimension (LVDd, 67 mm). Multidetector computed tomography angiography revealed no abnormalities in his coronary arteries, which raised the suspicion of dilated cardiomyopathy (DCM). Medical therapy was not initiated.

KEYWORDS Myocarditis; Recurrent myocarditis; Complete atrioventricular block; Complete heart block with ventricular standstill; Wearable cardioverter-defibrillator; Case report
(Heart Rhythm Case Reports 2023;9:496–500)

Funding Sources: None. **Disclosures:** All authors have no conflicts to disclose. **Patient Consent:** We confirm that the patient provided written consent for the submission and publication of this case report, including images.
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https://doi.org/10.1016/j.hrcr.2023.04.019

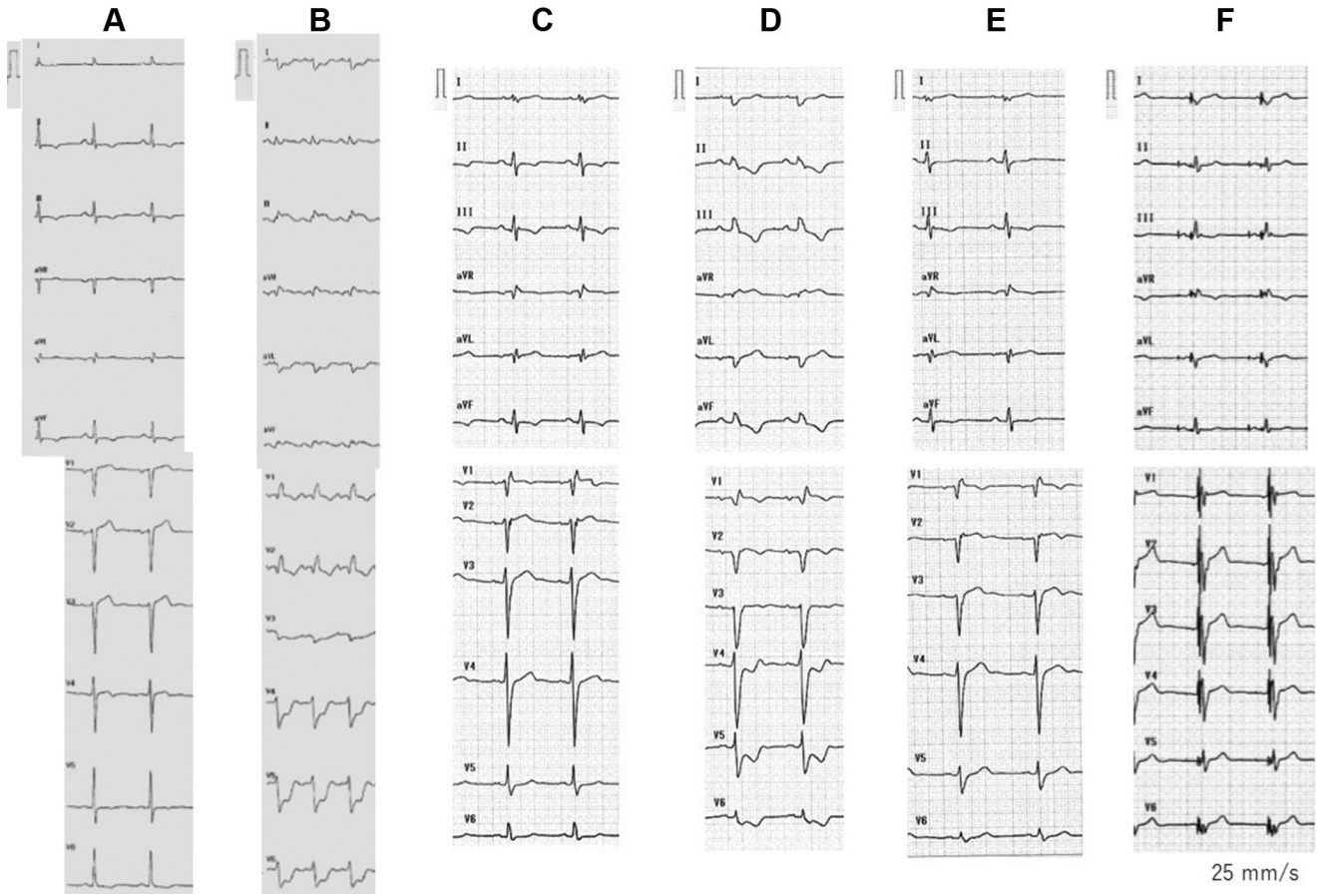

Figure 1 Transition of electrocardiograms (ECG) over the course of the case. **A:** ECG at 1 month before onset of fulminant myocarditis (FM). **B:** Extensive ST-T change and a wide QRS at the onset of FM. **C:** ECG at discharge after the treatment of fulminant myocarditis. **D:** ECG at the time of patient transfer at myocarditis recurrence showing a wide QRS complex (162 ms) and continued ST depression. **E:** ECG after the treatment of recurrent myocarditis and before implantation of a cardiac resynchronization therapy defibrillator (CRT-D). **F:** ECG after implantation of a CRT-D.

Two years later, the same patient presented to the emergency department with exertion dyspnea. He was not prescribed any medication. His ECG showed sinus rhythm and inversion of T wave in II, III, and aVF (Figure 1A). Chest radiography showed cardiac enlargement and pleural effusion, and he was diagnosed with congestive heart failure. Echocardiography revealed an LVEF of 27% and an LVDd of 67 mm. After the patient was started on medical therapies, such as diuretics and beta-blockers, his pleural effusion decreased and his symptoms improved as an outpatient. One month later, while attempting to intensify some medications, including angiotensin-converting enzyme inhibitors, the patient developed rapidly worsening dyspnea with a fever. On his ECG, ST depression and wide QRS in V_1–V_6 were detected (Figure 1B), and his LVEF declined to 15% (Supplemental Figure 1A). Emergency coronary angiography did not show any abnormality. The patient was in a state of cardiogenic shock on admission and was intubated. Intra-aortic balloon pumping and venoarterial extracorporeal membrane oxygenation were introduced. The next day, a complete AV block and sustained VT occurred, a temporary pacemaker was inserted, and intra-aortic balloon pumping was converted to a percutaneous left ventricular assist device (Impella). An endomyocardial biopsy demonstrated infiltration of numerous inflammatory cells, indicating lymphocytic FM (Figure 2A). The patient's creatine kinase levels reached a maximum of 1678 U/L at 6 days after admission. He was also treated with prednisolone (1 g methylprednisolone per day for 3 days) and intravenous immunoglobulin (2 g/kg for 2 days) for FM. His LVEF gradually improved, and he was weaned off of venoarterial extracorporeal membrane oxygenation and Impella on days 8 and 24, respectively. The patient's second myocardial biopsy, performed on day 22, revealed a decrease in infiltrated inflammatory cells and interstitial fibrosis, suggesting that his myocarditis had improved (Figure 2B). Dosages of beta-blocker (7.5 mg carvedilol per day), angiotensin-converting enzyme inhibitor (2 mg perindopril per day), mineralocorticoid receptor antagonist (25 mg spironolactone per day), and amiodarone (200 mg per day) were increased based on tolerability, and he was weaned off dobutamine on day 74. After the mechanical circulatory system was removed, the patient's AV conduction was restored, his sinus rhythm was maintained, and there was no bradycardic event. At discharge, the patient's NYHA classification was class II, and his brain natriuretic peptide (BNP) was 71.0 pg/mL (target range $<$20 pg/mL); his

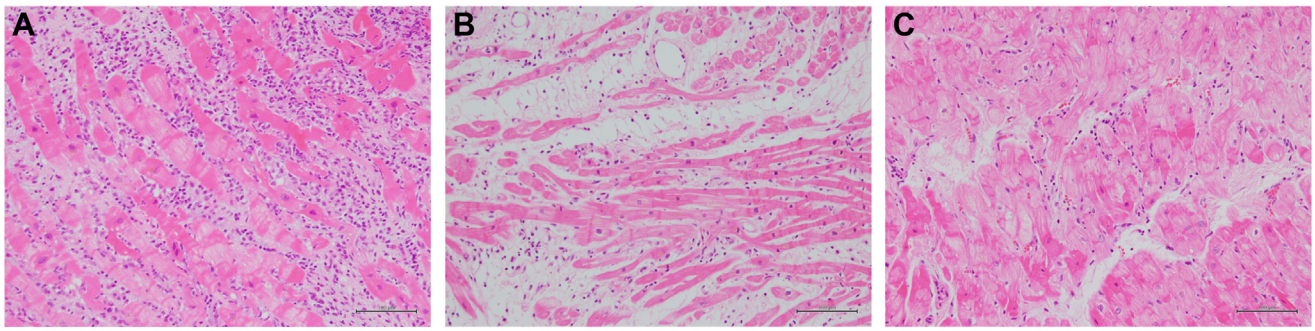

Figure 2 Images of cardiac biopsies. **A:** Myocardial biopsy on day 2 showed severe inflammatory lymphocytic cell infiltration in the cardiac interstitium. **B:** A follow-up biopsy on day 22 showed a decrease in infiltrated inflammatory cells and interstitial fibrosis. **C:** Myocardial biopsy on day 10 of the second admission showed mild inflammatory cell infiltration in the cardiac interstitium.

cardiac troponin T and I were slightly elevated at 0.022 ng/mL (target range <0.014 ng/mL) and 80.8 pg/mL (target range <26.2 pg/mL), respectively; and his C-reactive protein level was 0.03 mg/dL (target range <0.33 mg/dL), which was within the normal range. ECG before discharge showed sinus rhythm, a PQ interval of 180 ms, and a QRS duration of 132 ms (Figure 1C). Echocardiography revealed that his LVEF and LVDd were 35% and 70 mm, respectively (Supplemental Figure 1B). Cardiac magnetic resonance (CMR) imaging before discharge showed no signal on T2-weighted images and a high signal in the basal septum of the myocardium on late gadolinium enhancement (LGE) imaging (Supplemental Figure 2A and 2C). The patient was discharged on day 87 with a WCD for 3 months to prevent SCD.

After the patient was discharged, his medication was continued, and perindopril was increased to 4 mg on an outpatient basis. The patient's heart condition did not worsen for 2 months, and the WCD did not deliver any therapeutic shocks during this period. However, 9 weeks after hospital discharge, the patient experienced sudden dizziness and temporary loss of consciousness, and he was taken to the emergency room by ambulance. An ECG showed an advanced AV block (heart rate 35 beats/min), and a temporary pacemaker was inserted immediately. When we checked the records of the WCD, complete heart block with ventricular standstill for approximately 20 seconds and intermittently complete AV block were observed (Figure 3A and 3B). Under temporary cardiac pacing, his ECG (VVI 40) showed sinus rhythm at 62 beats/min with a wide QRS complex (162 ms) and ST depression in V_4–V_6 (Figure 1D). Laboratory testing revealed a normal C-reactive protein level, a slightly high white blood cell count (9020/μL), and a BNP level of 730.6 pg/mL. Creatine kinase showed no elevation (50 U/L), but cardiac troponin T and I levels increased to 0.193 ng/mL and 1208.1 pg/mL, respectively. Echocardiography revealed an LVEF of 29% and an LVDd of 67 mm (Supplemental Figure 1C). Coronary angiography showed no significant stenosis of the coronary arteries, and cardiac biopsy showed mild inflammatory cell infiltration in the cardiac interstitium (Figure 2C). Moreover, CMR imaging showed a new high signal on T2-weighted images and a clarified and expanded high signal on LGE images in the basal septum of the myocardium (Supplemental Figure 2B and 2D). These findings are consistent with the acute stage of myocarditis. Therefore, we diagnosed the patient with recurrent lymphocytic myocarditis and administered prednisolone and intravenous immunoglobulin. After these treatments, the ST-T changes and troponin levels decreased rapidly (Figure 1E). Finally, we decided to implant a cardiac resynchronization therapy defibrillator (CRT-D) because the patient had a reduced LVEF and wide QRS complex (152 ms) (Figure 1E). We did not continue any immunomodulation therapy following acute myocarditis. We plan to perform careful monitoring and long-term follow-up of this case of recurrent myocarditis. At 1 year after CRT-D implantation, the biventricular pacing rate was 98% (Figure 1F), and echocardiography showed improvement in cardiac function with LVEF of 45% and LVDd of 56 mm. The patient's BNP level and NYHA classification were 31 pg/dL and class I, and his heart failure did not worsen. Furthermore, his condition improved, without recurrence of myocarditis and arrhythmic events.

Discussion

We encountered a patient with recurrent myocarditis only 5 months after the onset of FM. He presented with sudden dizziness and syncope, and AV block and complete heart block with ventricular standstill were documented on his WCD. He had no history of myocarditis prior to the onset of FM and was asymptomatic; however, DCM was suspected.

We judged this second event as a relapse of myocarditis based on the symptoms of sudden onset, new ECG changes, elevated troponin levels, lymphocytic infiltration on biopsy, and CMR findings. Although a paired serum antibody test did not show a significantly elevated titer against any virus, it is highly likely that a virus was involved. The results of myocardial biopsy showed lymphocytic myocarditis. Pathogenically, a virus or toxin causes an initial myocyte injury, and the immune system is stimulated, which injures the myocardium. In most cases, viral clearance and downregulation of the immune response follow, but if viral infection or immune response is not controlled, ongoing injury on the myocardium leads to DCM.[7]

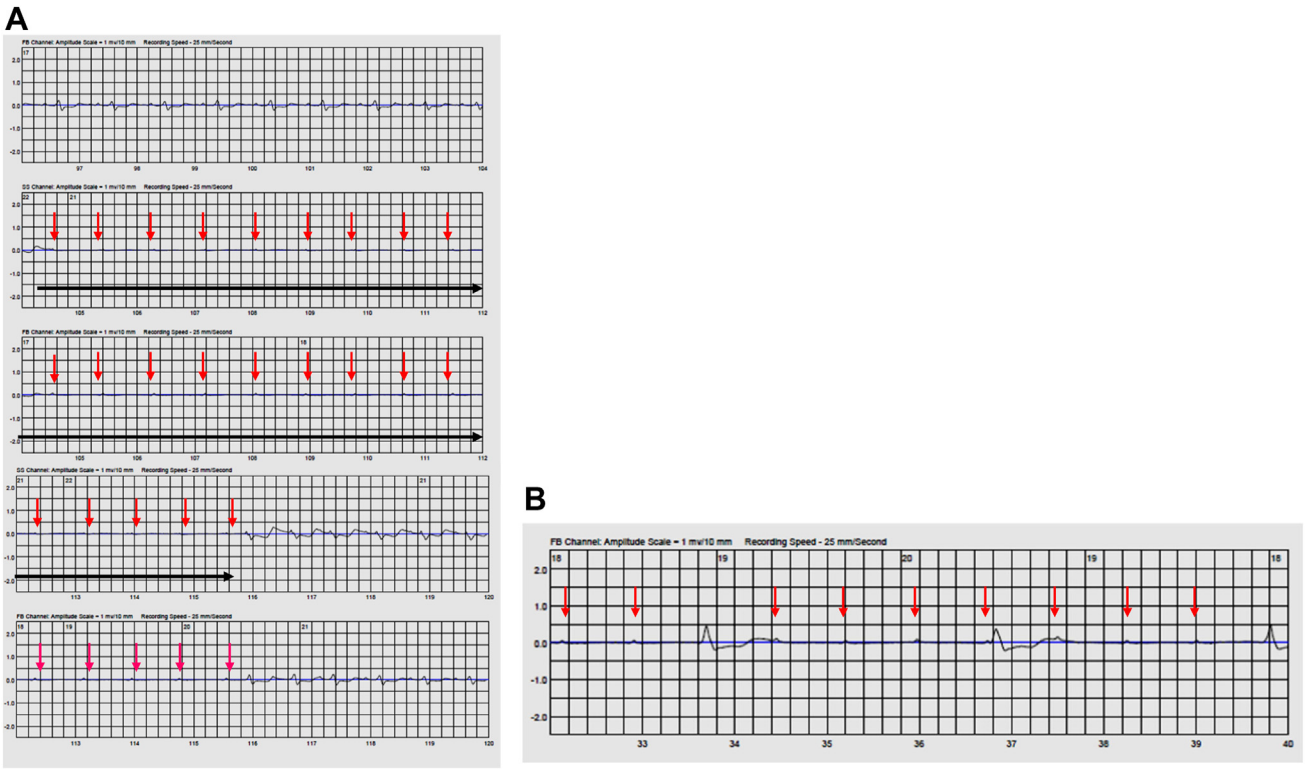

Figure 3 Wearable cardioverter-defibrillator recordings when the patient lost consciousness. **A:** Complete heart block with ventricular standstill for approximately 20 seconds. **B:** Complete atrioventricular block. Small red arrows indicate P wave.

The results of the myocardial biopsy showed lymphocytic myocarditis. Regarding the differential diagnosis, cardiac sarcoidosis was judged to be negative based on myocardial biopsy (no findings of noncaseating epithelioid granuloma), and serological tests revealed no elevation of angiotensin-converting enzyme, lysozyme, or serum soluble interleukin 2 receptor. The course of new T2 high signal on CMR in a short period is not typical for cardiac sarcoidosis.

The patient was discharged from the hospital with a WCD to prevent SCD after treatment for FM. A WCD is an external device for a patient with an increased risk for SCD. WCD can protect from SCD, bridging a vulnerable period until a decision on implantable cardioverter-defibrillator (ICD) implantation can be performed.[8] At discharge, approximately 3 months had passed, and his LVEF had improved but remained low, his BNP had decreased, and drug therapy was introduced for the first time; thus, further improvement in the patient's condition was expected. The patient had not yet consented to an ICD, and the option for ICD implantation was re-evaluated when the WCD was removed.

The use of WCD after myocarditis has been reported.[6,9] If VT or ventricular fibrillation is detected while wearing a WCD, the WCD can deliver shocks to save the patient's life. However, complete heart block occurring while wearing a WCD can only be recorded and not treated. In this case, the patient wore a WCD after the onset of FM, and AV block and complete heart block with ventricular standstill were recorded approximately 2 months after discharge. To the best of our knowledge, this is the first report of a case in which a WCD recorded an AV block and complete heart block with ventricular standstill caused by early recurrence of myocarditis.

The risk of SCD is especially high in cases where LVEF has not fully recovered or where there is LGE in the CMR images.[10] In this case, because DCM was suspected before the onset of FM, the risk of recurrence of myocarditis and SCD would have been high. Aggressive use of WCD may be considered in such a case.

Conclusion

We report for the first time a rare case of early recurrence of myocarditis in a patient who developed AV block and complete heart block with ventricular standstill while wearing a wearable defibrillator after FM. This impacts the use of WCDs in future myocarditis patients as part of the diagnostic and treatment process.

Acknowledgments

We thank Asami Yoshimura, MD, Hidetoshi Hattori, MD, Eri Watanabe, MD, Tsuyoshi Shiga, MD, Morio Shoda, MD, Nobuhisa Hagiwara, MD, and the "BIND team," a

multidisciplinary advanced heart failure treatment team at Tokyo Women's Medical University, for their support and helpful suggestions.

Appendix

Supplementary Data

Supplementary data associated with this article can be found in the online version at 10.1016/j.hrcr.2023.04.019.

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