Torsades de pointes following vaccination for COVID-19

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Introduction

Torsades de pointes is a polymorphic ventricular tachycardia that can cause syncope and lead to sudden cardiac death. This arrhythmia is initiated by early afterdepolarizations in the setting of prolonged ventricular repolarization, manifesting as QT prolongation on the 12-lead electrocardiogram (ECG).[1] Common risk factors include QT-prolonging medications, electrolyte disturbances, bradycardia, and certain inherited genetic mutations.[2] We report a case of torsades de pointes that occurred shortly after vaccination for COVID-19.

KEY TEACHING POINTS

- Vaccination against COVID-19 reduces the incidence of severe illness, hospitalization, and death owing to the virus and is associated with a low risk of adverse events.
- COVID-19 infection can cause QT prolongation attributed to excessive inflammation modulating potassium and calcium channels.
- We propose that an excessive immune response following vaccination for COVID-19 may lead to torsades de pointes via a similar mechanism to infection in a susceptible individual.

Case report

A 65-year-old woman with history of hypertension and left bundle branch block was referred to the electrophysiology clinic following a single episode of syncope. The episode occurred suddenly while sitting and was preceded by transient lightheadedness without palpitations. An ECG at that time demonstrated sinus rhythm with left bundle branch block, premature atrial complexes, and premature ventricular complexes at a heart rate of 78 beats per minute (QRS 164 ms, QT 454 ms, QTc 517 ms, JT 290 ms) (Figure 1A). An echocardiogram demonstrated a left ventricular ejection fraction of 45%–50% with left ventricular dyssynchrony and normal left ventricular wall thickness. The patient had previously completed her 2-dose vaccination series for the Pfizer-BioNTech COVID-19 vaccine, having received the second dose 1 month before her syncopal episode.

She underwent a diagnostic electrophysiology study, which demonstrated normal sinus node function, normal atrioventricular node function, and mildly abnormal His-Purkinje system conduction with negative procainamide challenge (HV interval 65 ms at baseline, prolonged to 73 ms following procainamide 10 mg/kg intravenous infusion over 10 minutes). After completion of the procainamide infusion, her QRS duration increased from 160 ms at baseline to 170 ms, her QTc increased from 525 ms at baseline to 630 ms, and her JT interval increased from 330 ms to 390 ms. Additionally, ventricular tachycardia was not inducible following programmed ventricular stimulation with 3 premature extrastimuli decremented to ventricular refractoriness at 2 drive train cycle lengths (600 ms and 400 ms) from the right ventricular apex. She ultimately received an implantable loop recorder.

Five months later, she received a third "booster" COVID-19 vaccination (Pfizer-BioNTech). Within 12 hours of receiving the vaccine, she suddenly became unresponsive while watching television. When she did not regain consciousness, her husband began cardiopulmonary resuscitation and contacted Emergency Medical Services. After paramedics arrived, application of an automated external defibrillator demonstrated ventricular fibrillation. Over the course of resuscitative efforts, she received 14 defibrillations.

Subsequent interrogation of her loop recorder demonstrated torsades de pointes (Figure 2A) with degeneration into ventricular fibrillation (Figure 2B). Her presenting ECG demonstrated an accelerated idioventricular rhythm at a heart rate of 79 beats per minute (Figure 1B). A repeat ECG soon after demonstrated sinus rhythm with left bundle branch block at a heart rate of 72 beats per minute (QRS

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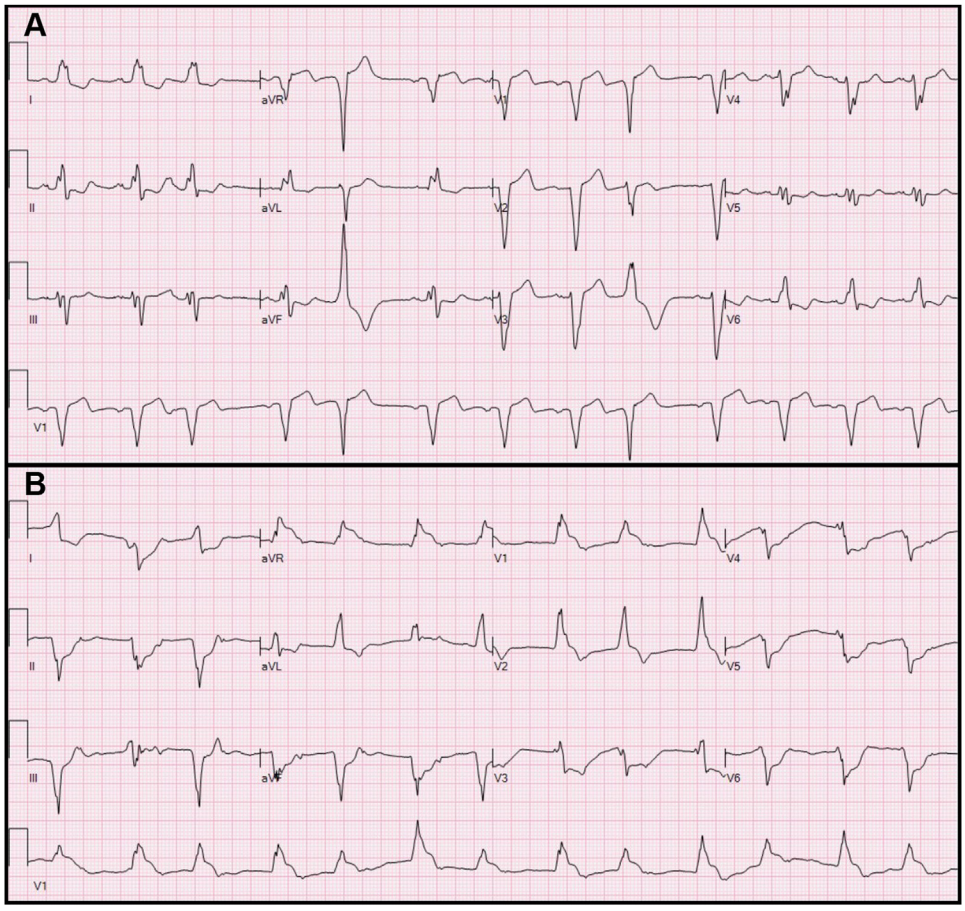

Figure 1 **A:** Presenting electrocardiogram (ECG) following the first episode of syncope. Heart rate 78 beats/min, QRS 164 ms, QT 454 ms, QTc 517 ms, JT 290 ms. B: Presenting ECG following cardiac arrest demonstrating an idioventricular rhythm at a heart rate of 79 beats/min.

160 ms, QT 540 ms, QTc 592 ms, JT 380 ms) (Figure 3A). Owing to the extensive burden of ventricular fibrillation during the cardiac arrest, amiodarone intravenous infusion was initiated.

She was intubated and subsequently underwent coronary angiography, which demonstrated normal coronary arteries. Her initial high-sensitivity troponin I level was 30 ng/L, which rose to 18,697 ng/L 10 hours later. Her presenting serum chemistry demonstrated normal a magnesium level of 2.4 mg/dL, a mildly low calcium level of 8.4 mg/dL, and a normal potassium level of 3.9 mmol/L. A repeat potassium level 3 hours later was 2.7 mmol/L, which was replenished intravenously. A rapid COVID-19 PCR test was negative on admission. Her initial echocardiogram showed a reduced ejection fraction of 19%, which later normalized to 50% after starting metoprolol succinate. She underwent targeted temperature management for 48 hours (temperature 33.2°C) to preserve brain function. Subsequent ECGs demonstrated progressive QT prolongation with a maximum QTc of 705 ms (Figure 3B).

Junctional rhythm subsequently occurred, prompting discontinuation of amiodarone and temporary initiation of epinephrine infusion to improve chronotropy. Brain magnetic resonance imaging demonstrated anoxic brain injury. Her hospitalization was further complicated by the development of ventilator-associated pneumonia with *Serratia marcescens* treated with intravenous piperacillin/tazobactam, followed by a catheter-associated urinary tract infection with *Candida albicans* treated with oral fluconazole, with close ECG monitoring. Following extubation, her neurologic function gradually returned. She underwent dual-chamber implantable cardioverter-defibrillator implantation with loop recorder explantation and successful defibrillator threshold testing. She was then discharged to a rehabilitation facility 7 weeks after admission.

Discussion

The cause of this patient's cardiac arrest is not completely understood. The ventricular arrhythmia recorded on the implantable loop recorder appears to be a polymorphic ventricular tachycardia with a twisting of points around a central axis, consistent with torsades de pointes, that rapidly degenerates into ventricular fibrillation. The QT interval on presentation was significantly prolonged compared to baseline, even when accounting for the left bundle branch block. However, this case was unusual as it was not preceded by a pause, which typically initiates this arrhythmia.

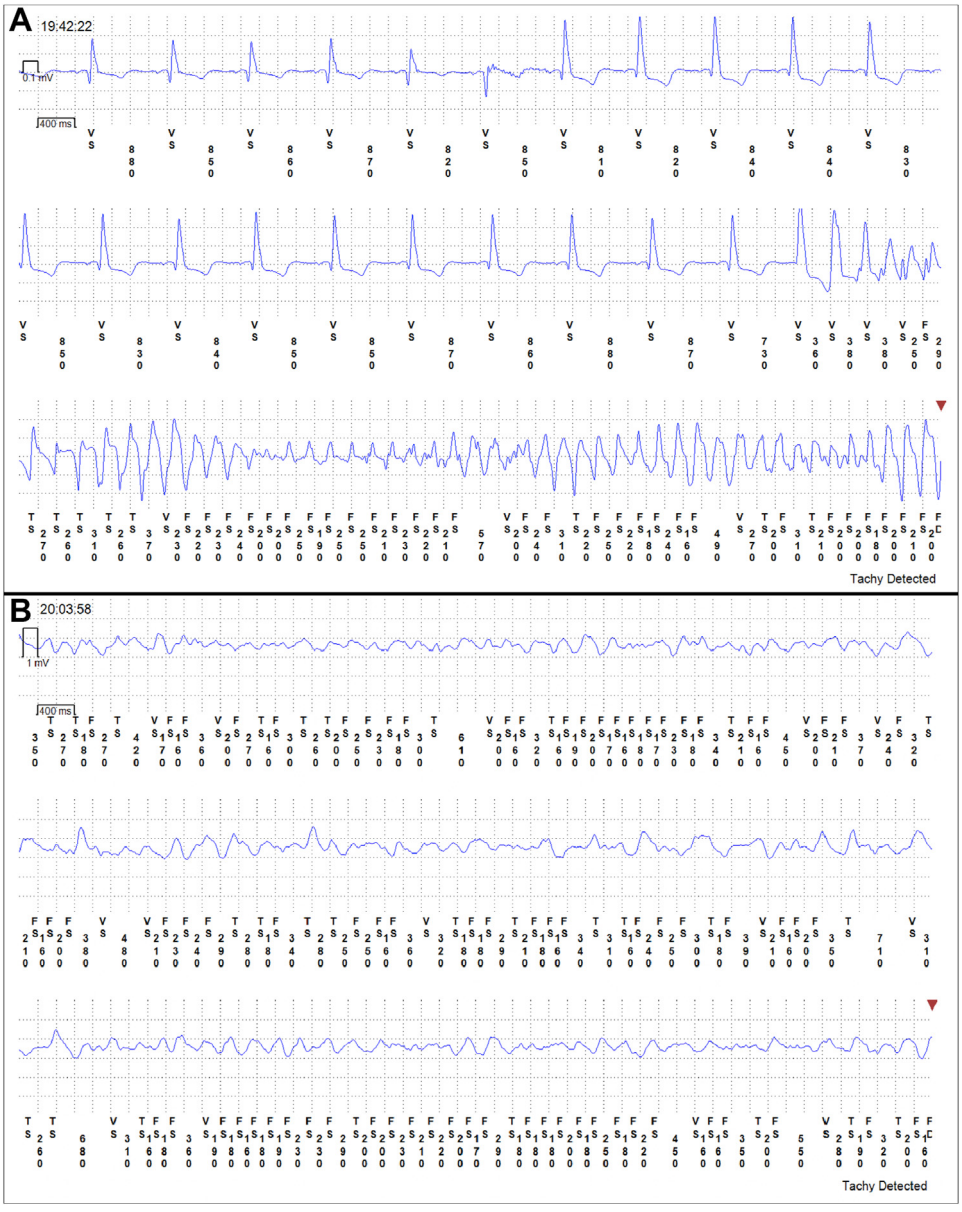

Figure 2 **A:** Presenting rhythm on implantable loop recorder showing initiation of torsades de pointes. **B:** Rhythm on implantable loop recorder several minutes later showing ventricular fibrillation.

An alternative explanation for the observed arrhythmia is ventricular fibrillation induced by a premature ventricular complex in the context of a mild nonischemic cardiomyopathy. This could explain why the QT interval does not appear to be significantly prolonged on the loop recorder rhythm strip in Figure 2A. However, the QT interval at this precordial location may not necessarily appear prolonged owing to regional differences in the QT interval between leads on a 12-lead ECG.[3] The presence of premature ventricular complexes on the presenting ECG in Figure 1 also supports this arrhythmia mechanism following her initial syncopal episode prior to loop recorder implantation. The presence of myocarditis, which has been linked to the COVID-19 vaccine by Pfizer-BioNTech,[4] may have also increased the risk of arrhythmogenesis. Unfortunately, detailed cardiac imaging with positron emission tomography or magnetic resonance imaging were not performed, as they were unavailable at the treating facility.

Following resuscitation from the cardiac arrest, our patient's presenting electrolytes demonstrated mild hypocalcemia, but serum potassium and magnesium levels were within normal limits; it was not until 3 hours following her initial presentation that she became profoundly hypokalemic, as would be expected from a prolonged cardiac arrest. The mechanism is thought to be from a transmembrane shift in potassium from the vascular space into cells caused by either a neurohumoral response to the cardiac arrest itself, catecholamine therapy during the arrest, or rapid correction of metabolic acidosis from the administration of bicarbonate and mechanical ventilation.[5,6]

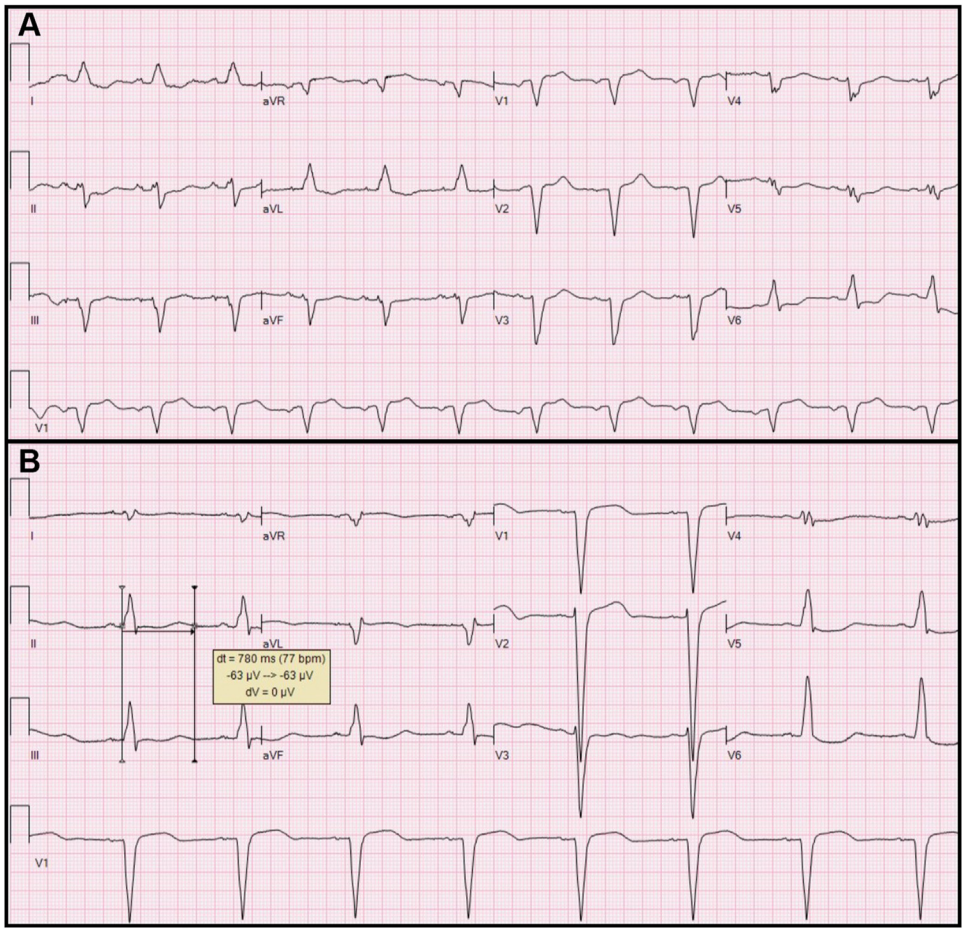

Figure 3 **A:** Repeat electrocardiogram (ECG) showing sinus rhythm with left bundle branch block at a heart rate of 72 beats/min. QRS 160 ms, QT 540 ms, QTc 592 ms, JT 380 ms. **B:** ECG while on amiodarone infusion showing sinus bradycardia at a heart rate of 49 beats/min. QRS 170 ms, QT 780 ms, QTc 705 ms, JT 610 ms.

The observed QT prolongation on subsequent ECGs could have been attributed to amiodarone and hypokalemia. The larger differences in the QT interval on different leads in Figure 3B (eg, lead II compared to V_2) suggest an elevated QT dispersion, which is also associated with an increased risk of ventricular arrhythmias.[3] The presence of an inherited channelopathy such as long QT syndrome was considered. She had no history of syncope as a child and there was no significant family history. Genetic testing was not performed. New-onset torsades de pointes in congenital long QT syndrome is rare starting at this age.

Given that her cardiac arrest occurred within 12 hours after receiving her COVID-19 vaccination, the vaccine itself should be considered as a potential contributor in a susceptible individual. However, it is also important to note that she did not report any significant side effects after receiving the first 2 doses of the same COVID-19 vaccine. Her single syncopal episode 1 month after receiving the second dose of the Pfizer-BioNTech COVID-19 vaccine may or may not have been related to the vaccine. It is possible that a nonsustained ventricular arrhythmia triggered by myocarditis could have caused her syncopal episode 1 month after the second vaccination, especially given the finding of a mildly reduced ejection fraction on her initial echocardiogram.

Vaccination against COVID-19 has been shown to reduce the incidence of severe illness, hospitalization, and death owing to the virus and is associated with a low risk of adverse events.[7] The Centers for Disease Control have recommended a booster vaccination for COVID-19 owing to waning immunity several months following an initial vaccination series.[8] Although torsades de pointes is not a known side effect of COVID-19 vaccination, infection with SARS-CoV-2 has been associated with QT prolongation.[9] This finding has been attributed to excessive inflammation modulating potassium and calcium channels that can lead to ventricular arrhythmias including torsades de pointes. An excessive immune response following vaccination to COVID-19 may have contributed to our patient's cardiac arrest via a similar mechanism to that seen in patients during active COVID-19 infection.

Conclusion

This is the first known case of polymorphic ventricular tachycardia in the setting of QT prolongation following COVID-19 vaccination. Whether this was an episode of torsades de pointes or ventricular fibrillation triggered by a premature ventricular complex is open for debate. Although

this case does not prove a definitive causal link to the vaccine, continued data collection and adverse event reporting following vaccination is paramount to ensure safety of widespread vaccinations for the novel coronavirus.

References

1. Sauer AJ, Newton-Cheh C. Clinical and genetic determinants of torsade de pointes risk. Circulation 2012;125:1684–1694.
2. Kallergis EM, Goudis CA, Simantirakis EN, Kochiadakis GE, Vardas PE. Mechanisms, risk factors, and management of acquired long QT syndrome: a comprehensive review. ScientificWorldJournal 2012;2012:212178.
3. Surawicz B. Will QT dispersion play a role in clinical decision-making? J Cardiovasc Electrophysiol 1996;7:777–784.
4. Salah HM, Mehta JL. COVID-19 vaccine and myocarditis. Am J Cardiol 2021; 157:146–148.
5. Thompson RG, Cobb LA. Hypokalemia after resuscitation from out-of-hospital ventricular fibrillation. JAMA 1982;248:2860–2863.
6. Salerno DM, Asinger RW, Elsperger J, Ruiz E, Hodges M. Frequency of hypokalemia after successfully resuscitated out-of-hospital cardiac arrest compared with that in transmural acute myocardial infarction. Am J Cardiol 1987;59:84–88.
7. Marfe G, Perna S, Shukla AK. Effectiveness of COVID-19 vaccines and their challenges (Review). Exp Ther Med 2021;22:1407.
8. Centers for Disease Control and Prevention. CDC Expands Eligibility for COVID-19 Booster Shots. October 21 2021. https://www.cdc.gov/media/releases/2021/p1021-covid-booster.html. Accessed October 23, 2021.
9. Etheridge SP, Asaki SY. COVID-19 infection and corrected QT interval prolongation—collateral damage from our newest enemy. JAMA Netw Open 2021; 4:e217192.