Malignant arrhythmia in a COVID-19 patient with a structurally normal heart

INTRODUCTION

Coronavirus disease 2019 (COVID-19)[1] is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a positive-sense, single-stranded ribonucleic acid virus. Initially reported in Wuhan, China, COVID-19 has since spread to become a global pandemic.[2] Patients typically present with upper respiratory tract symptoms, which can rapidly progress to severe respiratory, multiorgan failure and mortality.[3,4] SARS-CoV-2 has multiple system effects, with one of the most important complications being cardiovascular.[3] These complications may be due to direct viral-induced myocardial injury[4] and myocarditis.[5] Also, underlying cardiac comorbidities may be exacerbated by hypercoagulability and extensive inflammation,[1] leading to acute myocardial infarction, myocardial infarction with non-obstructive coronary arteries,[6] heart failure and cardiac arrest.[7] Another major reason for sudden cardiovascular deterioration could be arrhythmias. Possible mechanisms include atrial[8] and ventricular[9] arrhythmias in the setting of cardiomyopathy. However, arrhythmias may occur even in a patient with a structurally normal heart, as shown in the following case.

CASE DESCRIPTION

A 65-year-old Indian man presented to the emergency department with 5 days of fever, non-productive cough and mild dyspnoea. He did not smoke and had well-controlled hypertension, for which he was not on medication. At presentation, he had normal blood pressure (117/74 mmHg), mild tachycardia (102 beats/min) and peripheral oxygen saturation of 95% on room air. Physical examination revealed normal heart sounds, right basal crepitations, and absence of both elevated jugular venous pressure and lower limb oedema. Chest X-ray showed bilateral hilar and right mid-zone opacities [Figure 1]. Electrocardiogram (ECG) showed sinus rhythm of 97/min, QRS duration of 74 ms, corrected QT duration of 406 ms and no ST-segment deviation [Figure 2]. Pertinent laboratory findings included: white cell count 4.87 × 10^9/L (reference range: 3.84–10.01 × 10^9/L); haemoglobin 15.9 (13.1–16.6) g/dL;

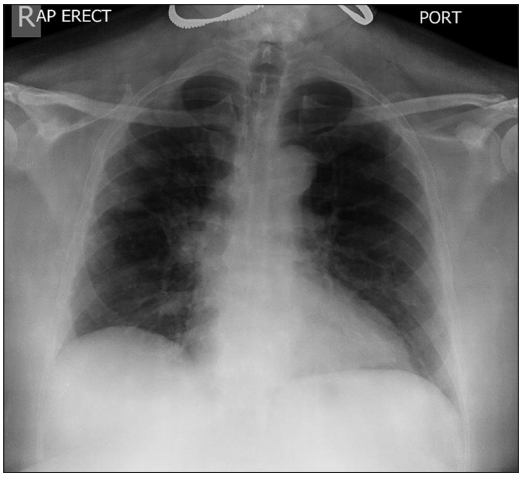

Figure 1: Chest radiograph shows bilateral hilar and right lower zone opacities.

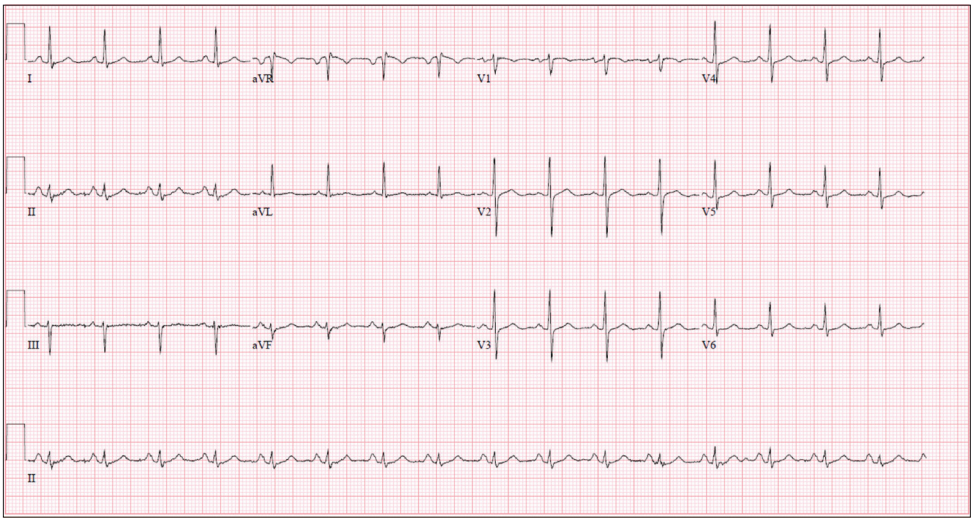

Figure 2: ECG on admission shows sinus rhythm.

platelet count 169 × 10^9/L (164–387 × 10^9/L); creatinine 101 (60–107) μmol/L; sodium 128 (134–145) mmol/L; potassium 4.5 (3.5–5.0) mmol/L; calcium adjusted for albumin 2.18 (2.15–2.55) mmol/L; magnesium 0.82 (0.75–1.07) mmol/L; C-reactive protein 90 (0–10) mg/L; lactate dehydrogenase 872 (250–580) U/L and a normal high-sensitivity troponin I of 17.0 (0–17.8) ng/L. COVID-19 was subsequently diagnosed based on real-time reverse-transcriptase polymerase chain reaction of a nasopharyngeal swab sample.

The patient initially received supportive treatment in the general ward under the Department of Medicine and was kept under airborne precautions. However, he developed hypoxaemic respiratory failure on Day 2 of hospitalisation (Day 6 of illness) and was transferred to the intensive care unit (ICU). On arrival to ICU, his blood pressure was 131/95 mmHg, heart rate was 100 beats/min and oxygen saturation was 99% on 4 L/min nasal prongs. Physical examination revealed bilateral basal crepitations, dual heart sounds with no murmurs or added sounds and no pedal oedema. Bedside ultrasound revealed normal heart structure and preserved left ventricular ejection fraction. There was no pericardial effusion. His C-reactive protein rose to 193 mg/L and then to 937 mg/L. On Day 3 of hospitalisation (Day 7 of illness), the patient developed acute respiratory distress syndrome requiring invasive mechanical ventilation and paralysis [Figure 3], oliguric acute kidney injury requiring continuous renal replacement therapy and vasodilatory shock requiring the use of noradrenaline (0.2 mcg/min) and vasopressin (0.03 units/min).

On Day 5 of hospitalisation (Day 9 of illness), despite cardiorespiratory stability, the patient unexpectedly developed ventricular tachycardia (VT) resulting in cardiac arrest. Before the arrest, he had been on noradrenaline (0.06 mcg/min) and off vasopressin. Pertinent laboratory values just before the onset of VT included: sodium 127 (reference range: 134–145) mmol/L; potassium 4.5 (3.5–5.0) mmol/L; calcium adjusted for albumin 2.36 (2.15–2.55) mmol/L; magnesium 0.82 (0.75–1.07) mmol/L; and phosphate 1.60 (0.85–1.45) mmol/L. He received immediate cardiopulmonary resuscitation, defibrillation and intravenous amiodarone. There was return of spontaneous circulation after 6 min of resuscitation. Retrospective review of his continuous ECG monitoring record revealed sudden deterioration of baseline sinus rhythm into an idioventricular rhythm (rate 60 beats/min) [Figure 4a]. Subsequently, a run of VT was started by a premature ventricular complex (PVC) falling on the preceding T wave [Figure 4b]. Upon successful resuscitation and return of spontaneous circulation, ECG returned to sinus rhythm with narrow QRS complexes [Figure 4c]. There was no evidence of atrioventricular nodal block, QT duration prolongation or ST-segment deviation suggestive of ischaemia. Postresuscitation, his serial troponin I levels were mildly elevated at 41.3 and 85.0 (0.0–17.4) ng/L. His N-terminal-prohormone of brain natriuretic peptide was 223 (0–241) pg/mL. Repeat echocardiogram revealed preserved left ventricular function, and strain imaging confirmed normal deformation (global longitudinal strain: –16% [M9; Mindray Bio-Medical Electronics Co., Ltd, Shenzhen, China]). There was no recurrence of arrhythmia, and the patient was weaned off renal replacement therapy and successfully extubated after 8 days of mechanical ventilation. He was transferred to the general ward and discharged after undergoing rehabilitation.

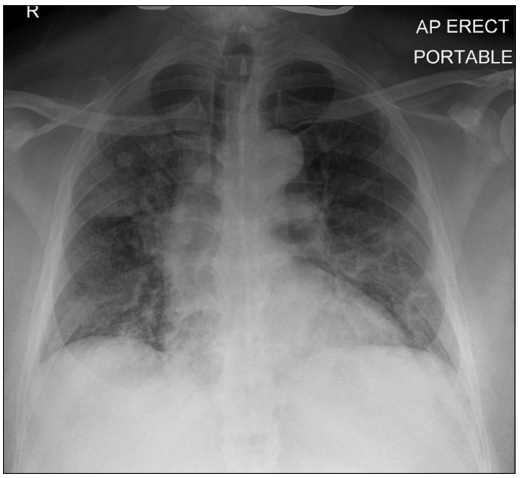

Figure 3: Chest radiograph on transfer to the intensive care unit shows worsening bilateral infiltrates.

DISCUSSION

COVID-19 infection has been associated with cardiovascular complications, including myocardial injury as evidenced by elevated troponin levels. SARS-CoV-2 appears to involve the myocardium, and sporadic autopsy cases suggest an infiltration of interstitial mononuclear inflammatory cells within the myocardium.[10] The virus has an affinity for the host angiotensin-converting enzyme 2 receptor, which raises the possibility that it may directly infect the myocardium and vascular endothelium.[11] Although acute myocarditis with depressed left ventricular function has been described in patients diagnosed with COVID-19,[6] our patient highlights the potential of COVID-19 to cause malignant arrhythmias despite a normal ejection fraction, ECG and troponin level.

In terms of myocardial injury, Shi *et al*.[4] studied a cohort of 416 hospitalised patients with COVID-19, of whom 82 (19.7%) had elevated troponin I levels. Similarly, Guo *et al*.[9] reported that among 187 patients with COVID-19, 52 (27.8%) had elevated troponin T levels. Both studies demonstrated that patients with myocardial injury had a significantly higher in-hospital mortality rate compared to those without. These patients tended to be older and had existing health conditions such as coronary artery disease, heart failure, hypertension and diabetes mellitus. They also had higher leucocyte counts, C-reactive protein and procalcitonin levels. Previous SARS coronavirus infections have been known to be associated

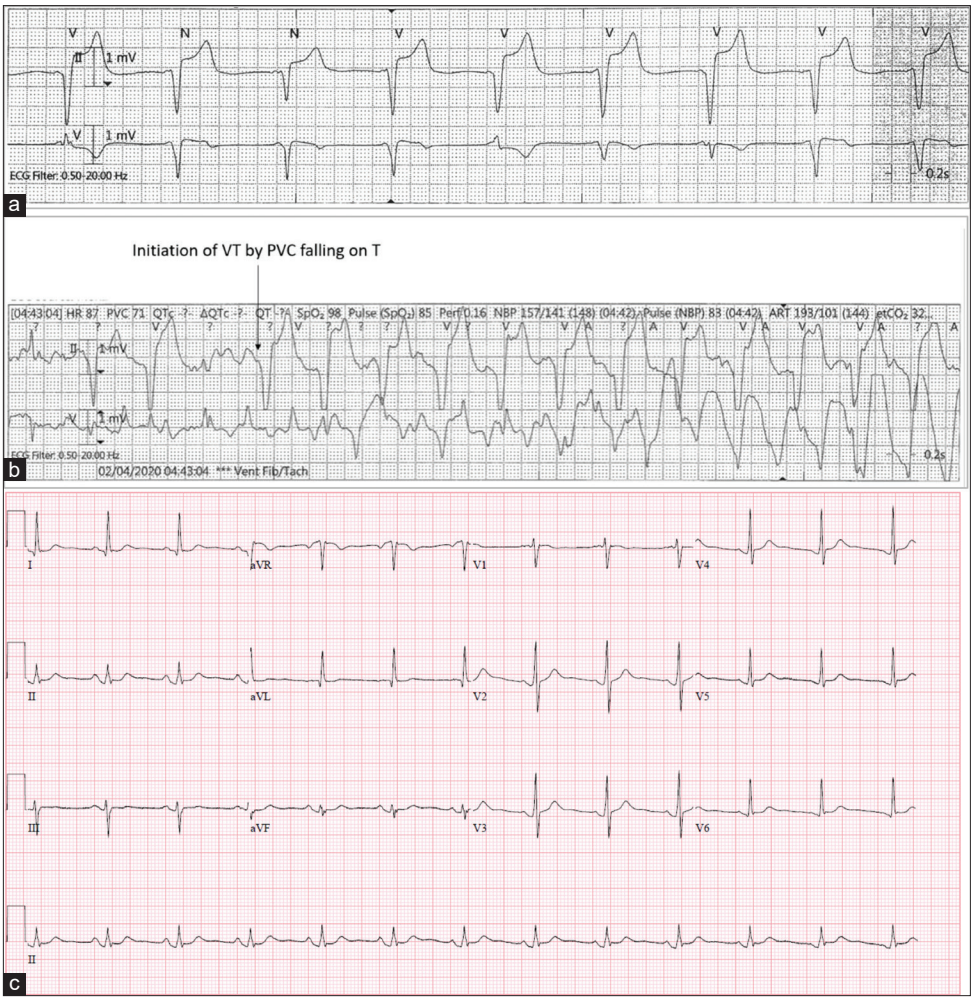

Figure 4: (a) Telemetry strip before cardiac arrest shows idioventricular rhythm before collapse; (b) Subsequent telemetry strip shows the initiation of ventricular tachycardia by premature ventricular complex falling on the preceding T wave. (c) ECG after spontaneous return of circulation shows return to sinus rhythm with narrow QRS complexes.

with tachyarrhythmias[12] and specifically to COVID-19. Wang *et al*.[3] described the occurrence of arrhythmias in 23 (16.7%) patients out of a cohort of 138 patients with COVID-19 infection, for which the prevalence increased to 44.4% in the 16 patients who were admitted to ICU. Separately, Guo *et al*.[9] reported that out of 187 patients, 11 (5.9%) had VT or ventricular fibrillation, two of whom had normal troponin T.

To our knowledge, no previous study has demonstrated the occurrence of malignant arrhythmia in COVID-19 patients who had no abnormality found on echocardiography, ECG or initial troponin assay. Our patient demonstrated that COVID-19 could lead to arrhythmic collapse in the absence of any conventional risk factors. Given complete normalisation of ECG and normal postresuscitation heart function, it is unlikely that acute myocardial infarction, septic cardiomyopathy[13] or acute myopericarditis[14] had led to VT in our patient. Furthermore, as the precollapse heart rate was only 60 beats/min, it is unlikely that autonomic imbalance triggered VT.[15] In addition, as VT did not recur, we propose that COVID-19 infection could transiently and focally affect the cardiac conduction system through a mechanism that is currently unknown.

The vulnerable period for malignant arrhythmia appears to be during COVID-19-associated inflammation, as marked by the increase in C-reactive protein and ferritin levels before our patient's VT collapse. During this period, COVID-19 can induce multiorgan failure, including acute respiratory distress syndrome, acute kidney injury and septic shock,[3] which is also the time when there should be heightened alertness for complications and increased monitoring.

In conclusion, our patient's experience shows that COVID-19 has the potential to cause sudden death via the development of malignant arrhythmia. Even though VT occurred during the phase of multiorgan dysfunction in our patient, his cardiac function on echocardiography and electrical rhythm on ECG were not affected. It seems possible that malignant arrhythmia could also occur in patients with less-severe non-cardiac manifestations, including patients with mild respiratory failure nursed in the general ward. Without continuous

ECG monitoring, sudden cardiovascular collapse could be erroneously ascribed to cardiomyopathy or rapidly worsening respiratory failure. Conversely, if malignant arrhythmia could be detected and defibrillated promptly, clinical outcomes can be excellent. Based on lessons learnt from our case, we propose that ECG monitoring and defibrillator units be made readily available for COVID-19 patients, especially those in the inflammatory phase of their disease.

Financial support and sponsorship

Nil.

Conflicts of interest

See KC is a member of the SMJ Editorial Board, and was thus not involved in the peer review and publication decisions of this article.

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Received: 12 Feb 2021 **Accepted:** 21 May 2021 **Published:** 08 Nov 2021

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Website: https://journals.lww.com/SMJ

DOI: 10.11622/smedj.2021191

How to cite this article: Fong CAY, Tung BWL, Lin W, See KC. Malignant arrhythmia in a COVID-19 patient with a structurally normal heart. Singapore Med J 2023;64:683-6.