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CASE REPORT
Other

Massive pulmonary embolism in a COVID-19 patient: a case report

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Background Myocardial injury is associated with excess mortality in severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections, and the mechanisms of injury are diverse. Coagulopathy associated with this infection may have unique cardiovascular implications.

Case summary We present a case of 62-year-old male who presented after experiencing syncope and cardiac arrest. Given the clinical presentation and electrocardiographic findings, there was concern for acute coronary syndrome. However, coronary angiogram did not reveal significant coronary obstruction. Due to the unclear nature of his presentation, a bedside echocardiogram was rapidly performed and was indicative of right ventricular strain. Due to these findings, a pulmonary angiogram was performed that revealed massive pulmonary embolism. He successfully underwent catheter-directed thrombolysis and, after a prolonged hospital stay, was discharged home on lifelong anticoagulation.

Discussion The impact of coronavirus disease-2019 (COVID-19) on the cardiovascular system has been prominent and multifaceted. COVID-19 can have wide-ranging effects on the cardiovascular system due to coagulopathy with resultant venous and arterial thrombo-embolism. Due to the critical condition of many patients affected by COVID-19, imaging for thrombo-embolic events is often delayed. With the use of bedside echocardiogram, observation of right ventricular strain may be critical in raising suspicion for pulmonary embolism, especially when atypical features are noted on electrocardiogram.

Keywords Coronavirus disease 2019 • Severe acute respiratory syndrome coronavirus 2 • ST-segment elevation myocardial infarction • Pulmonary embolism • Coagulopathy • Case report

Learning points

- COVID-19 is associated with a coagulopathy leading to increased rates of thrombo-embolic events.
- Early recognition of right ventricular strain with the use of bedside echocardiogram can be critical in raising suspicion for diagnosis.
- Early prophylactic anticoagulation should be considered in those with COVID-19 due to higher risk of thrombotic complications.

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Introduction

In December 2019, mysterious cases of pneumonia emerged in Wuhan, China. Since this time, the novel severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) has spread to 185 countries infecting >2 500 000 people and causing over 180 000 deaths.[1] The impact of coronavirus disease 2019 (COVID-19) on the cardiovascular system has been prominent and multifaceted.[2] Interestingly, COVID-19 may have wide-ranging effects on coagulation and contribute to venous and arterial thrombo-embolism.[3] In an effort to aid clinicians caring for these patients, we describe a case of massive pulmonary embolism presenting as an out-of-hospital cardiac arrest in a patient with COVID-19.

Timeline

Day 0	Experiences syncope and out-of-hospital cardiac arrest. ECG en rute to hospital concerning for ST-elevations in anterior leads
Day 0: 1 h	ECG on arrival with slow, wide complex tachycardia. Due to concern for acute coronary syndrome, coronary angiogram performed but did not reveal coronary stenosis.
Day 0: 6 h	Bedside echocardiogram with depressed right ventricular function. Pulmonary angiogram with bilateral pulmonary emboli. Catheter-directed thrombolysis administered
Day 4	Computed tomography of chest obtained with persistent ground-glass opacities. COVID-19 testing performed and positive
Day 8	Extubated
Day 28	Discharged home on lifelong anticoagulation

Case presentation

A 62-year-old male with hypertension and hyperlipidaemia presented to an urgent care clinic with 7 days of dizziness, fatigue, nausea, and vomiting. He was transported to the emergency department, evaluated, and discharged home. Approximately 4 days later, emergency medical services were called after the patient experienced syncope. Electrocardiogram (ECG) obtained en route reported anterior ST-segment elevations. Before arrival at the hospital he developed ventricular fibrillation. Cardiac defibrillation was successful and endotracheal intubation was performed. Upon arrival at the emergency department, ventricular fibrillation recurred, and resuscitative efforts restored sinus rhythm and spontaneous circulation. Following return of spontaneous circulation, exam was notable for heart rate of 77 b.p.m., a regular rhythm, and hypotension (86 mmHg/48 mmHg). There were no appreciable murmurs. There was no lower extremity oedema. The extremities were cool to touch. On pulmonary exam, he required mechanical ventilation with a rate of 28, tidal volume 500 mL, FiO_2 100%, and positive end-expiratory pressure of 8 cmH_2O. Breath sounds were present bilaterally. The subsequent ECG showed wide complex rhythm consistent with slow ventricular tachycardia with right bundle branch block morphology and left axis deviation. (*Figure 1*).

Given the report of ST elevations prior to ventricular fibrillation, along with the ECG at presentation, there was high suspicion for acute coronary syndrome. He received aspirin, ticagrelor, and heparin for a presumed ST-segment elevation myocardial infarction. Epinephrine infusion was started due to bradycardia with hypotension. He was emergently taken to the catheterization lab, but coronary angiography did not reveal coronary stenosis. Right heart catheterization revealed elevated right-sided filling pressures with a right atrial pressure of 22 mmHg, pulmonary artery pressure 61/28 (39) mmHg, pulmonary capillary wedge pressure 15 mmHg, and Fick cardiac index 2.6 L/min/m^2. Due to the unclear nature of his presentation, point-of-care echocardiogram was performed, and demonstrated a dilated right ventricle with severely reduced function. Based on point-of-care echocardiogram findings, there was concern for pulmonary embolism. Immediate pulmonary angiography was performed and revealed large, bilateral pulmonary emboli (Supplementary material online, *Video 1*). EkoSonic™ endovascular thrombolysis catheters were advanced into both main pulmonary arteries and 5 mg of tissue plasminogen activator was delivered through each catheter, followed by 2 mg/catheter/h for 2 h, then 1 mg/catheter/h for 16 h. Infusion was guided by fibrinogen monitoring as per institutional protocol.

Upper and lower extremity Doppler ultrasounds were obtained but showed no evidence of venous thrombosis. Formal transthoracic echocardiogram confirmed depressed right ventricular function (Supplementary material online, *Video 2*). Computed tomography (CT) of the chest showed bilateral peripheral ground-glass opacities with wedge-shaped opacities in the right lung (*Figure 2*). These were thought to represent pulmonary infarctions, but, given refractory hypotension requiring vasopressors, he was started on broad-spectrum antibiotics for pneumonia. A viral respiratory panel was negative, but tracheal aspirate culture was positive for methicillin-resistant *Staphylococcus aureus*. Following completion of catheter-directed thrombolysis, repeat ECG showed sinus rhythm with first-degree atrioventricular (AV) block, left axis deviation, incomplete right bundle branch block, and prolonged QTc interval (498 ms) (*Figure 3*). Over the following 4 days, he developed anaemia, and CT of the chest, abdomen, and pelvis showed a mediastinal haematoma and persistent ground-glass opacities (*Figure 4*). Given his radiographic findings, and growing prevalence of COVID-19, he was tested for SARS-CoV-2 and found to be positive. He was transferred to a COVID-19-dedicated intensive care unit where he was placed under enhanced contact precautions and received supportive care. He was extubated 4 days later. Following extubation, he did well. He was admitted to an inpatient rehabilitation facility and discharged home on lifelong apixaban 5 mg twice daily. At 1 month follow-up, he described mild exertional dyspnoea that was improving. Transthoracic echocardiogram at that visit noted improvement of

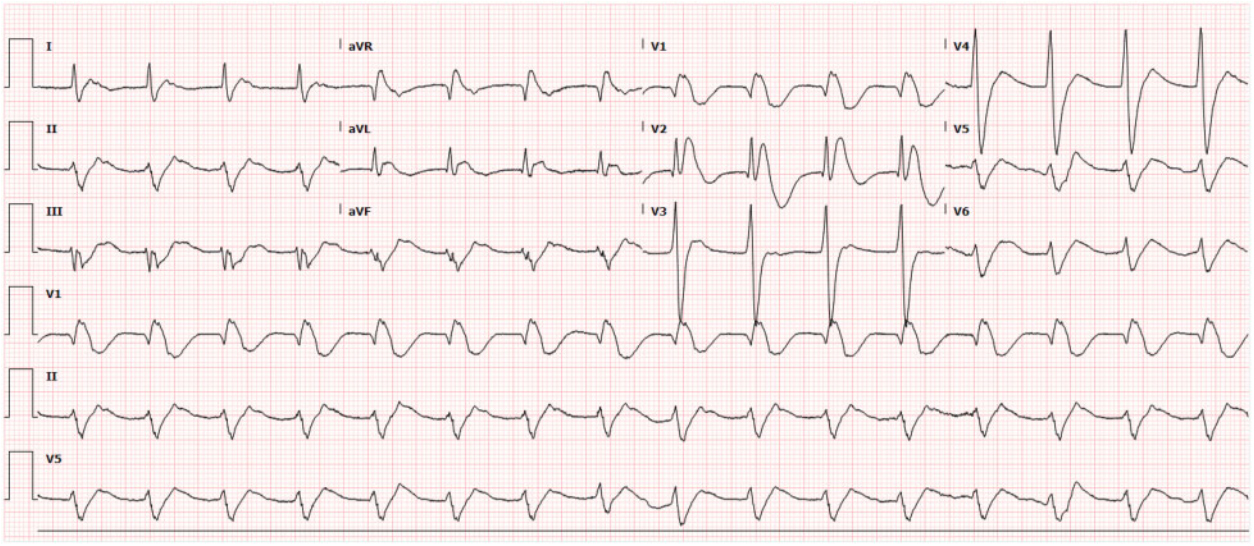


Figure 1 ECG showing wide complex rhythm consistent with slow ventricular tachycardia with right bundle branch block morphology and left axis deviation.

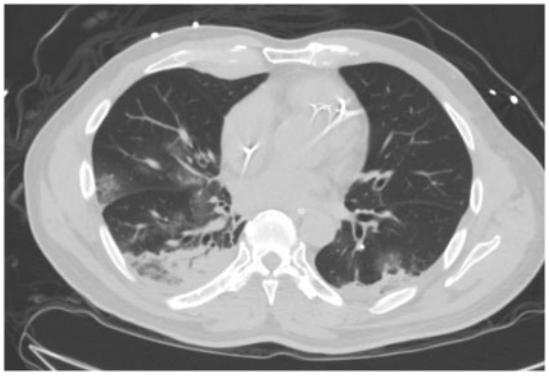


Figure 2 CT chest revealing bilateral peripheral ground-glass opacities with peripheral wedge-shaped opacities in the right lung.

right ventricular dilation and systolic function (Supplementary material online, *Video 3*).

Discussion

This patient presented with syncope, ventricular fibrillation, and shock secondary to a massive pulmonary embolism in the setting of SARS-CoV-2 infection. The overall prevalence of venous thrombo-embolism in the setting of COVID-19 is poorly defined, with current case series suggesting as many as 20.6–25% of patients admitted may have concurrent thrombo-embolic phenomena.[4,5]

It is recognized that COVID-19 causes a coagulopathy associated with elevated D-dimer, prolonged prothrombin time, and reduced fibrinogen. The mechanisms behind the coagulopathy are unclear, and some theories postulate the up-regulation of cytokines as possible contributors, while others believe hepatic dysfunction with resultant coagulopathy may play a role.[3] Regardless of the mechanism, it is apparent that there is increased prevalence of thrombotic events in patients with COVID-19.

This coagulopathy often progresses to disseminated intravascular coagulation,[6] causing both venous and arterial thrombosis, and portends a poor prognosis. One report found that 71.4% of patients who died from COVID-19 met criteria for disseminated intravascular coagulation.[6] In COVID-19, many patients meet the Third International Consensus Definitions for Sepsis and Septic Shock.[7] Disseminated intravascular coagulation represents a major cause of organ dysfunction in sepsis, and the use of anticoagulant therapy in this setting is controversial.[8] The term sepsis-induced coagulopathy (SIC) was coined by the International Society of Thrombosis and Hemostasis, and represents an earlier phase in the progression of disseminated intravascular coagulation. Using a SIC score, administration of systemic anticoagulation may be helpful in improving the hypercoagulable state, organ dysfunction, and hospitalizations associated with sepsis.[8] In a retrospective, single-centre study, administration of prophylactic low molecular weight heparin was associated with reduced 28-day mortality in severe COVID-19 patients with concurrent coagulopathy, defined as a SIC score >4 (40% vs. 64.2%, $P = 0.029$) or D-dimer >3 μg/mL (32.8% vs. 52.4%, $P = 0.017$).[9]

Given the prevalence of the disease and associated coagulopathy, patients with unexplained deep venous thrombosis or pulmonary embolism should raise concern for COVID-19. However, the diagnosis of venous thrombo-embolism remains challenging in this setting. Many barriers to routine imaging for these conditions include patient instability, poor image quality due to patient management parameters (i.e. proning), and increased exposure risk to healthcare workers.[3] Our case highlights the importance of echocardiography, particularly at the bedside. Evaluation of decreased right ventricular function was

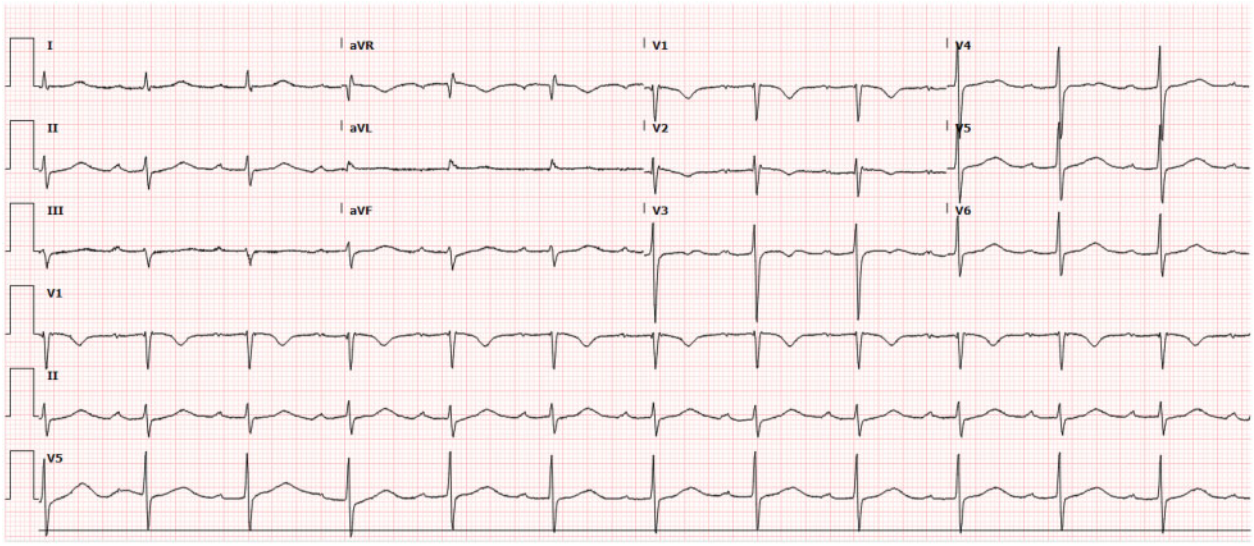


Figure 3 ECG showing sinus rhythm with first-degree AV block, left axis deviation, incomplete right bundle branch block, and prolonged QTc interval (498 ms)

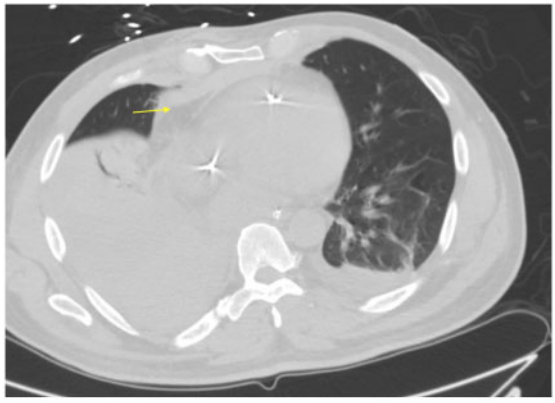


Figure 4 CT chest revealing mediastinal haematoma and persistent ground-glass opacities.

Table 1 Lab results on admission

Lab	Value	Reference range
Lactic acid	19 (mmol/L)	0.5–2.2 (mmol/L)
Troponin I initial	77 (ng/L)	3–20 (ng/L)
Troponin I peak	6424 (ng/L)	3–20 (ng/L)
Brain natriuretic peptide	127 (pg/mL)	0–100 (pg/mL)
Prothrombin time	18.2 (s)	12–14.5 (s)
International normalized ratio	1.51	(NA)
Partial thromboplastin time	28 (s)	25–35 (s)
Fibrinogen	193 (mg/dL)	220–498 (mg/dL)
D-dimer	>20 000 (ng/mL)	0–240 (ng/mL)

critical in raising suspicion for, and ultimately diagnosing, his pulmonary embolism. As such, it is reasonable to consider echocardiography to assess for right ventricular dysfunction as a clue to diagnosis in this setting.[3]

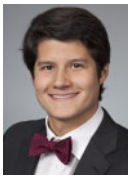
In our patient, his rapid recovery, despite the acuity of his illness, was surprising. Catheter-directed thrombolysis contributed to his recovery, but his course would probably have benefited from anticoagulation, independent of its effects on the pulmonary embolism. To our knowledge, this is the first case of COVID-19-associated pulmonary embolism successfully treated with catheter-directed thrombolysis.

With these limitations, empiric thromboprophylaxis with low molecular weight heparin may provide benefit in this population. As such, expert opinion recommends prophylactic low molecular weight heparin be administered to all COVID-19 patients requiring hospitalization unless thrombocytopenia is present (defined as platelet count $<25 \times 10^9$/L) or fibrinogen levels are <0.5 g/L.[10]

Conclusions

COVID-19-associated coagulopathy may present with incidental thrombo-embolic phenomena. It is imperative to maintain a high index of suspicion for these complications when caring for patients with COVID-19. Empiric thromboprophylaxis may have clinical benefit in reducing these complications. Furthermore, as standard imaging may not be feasible, echocardiogram may offer further evidence to raise suspicion of pulmonary embolism.

Lead author biography



Charlie Sang III was born in Greenville, NC, USA in September 1991. He received his undergraduate degree in Exercise and Sport Science at the University of North Carolina at Chapel Hill and studied medicine at the Brody School of Medicine at East Carolina University. He is currently training in a combined residency in Internal Medicine–Paediatrics at the University of Alabama at Birmingham. He has a broad interest in cardiovascular disease in both the paediatric and adult populations.

Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports* online.

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Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: Despite repeated attempts by the authors, they were unable to contact the patient to obtain informed consent. The authors confirm they have obtained approval from the University of Alabama at Birmingham, Birmingham, AL, USA Institutional Review Board for the creation and publication of this manuscript and are in compliance with national and institutional ethical standards. The case has been fully anonymised. This has been discussed and agreed with the editors.

Conflict of interest: none declared.

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