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CASE SERIES
Cardiac Imaging

Contrast echocardiography facilitates appropriate management of hospitalized patients with coronavirus disease 2019 (COVID-19) and suspected right ventricular masses: case series

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Background Coronavirus disease 2019 (COVID-19) infection is associated with a coagulopathy with high incidence of venous thrombo-embolism. However, bleeding risk is also significant, causing difficulty in initiating and adjusting anticoagulation therapy in case of suspected thrombi. Cardiac masses can be challenging to be identified properly in the context of this disease. The use of bedside contrast echocardiography (CE) can be of a great value in this situation decreasing procedure-related risk and allowing proper diagnosis and management of a cardiac mass.

Cases summary We present two cases who were admitted with severe COVID-19 infection. Both cases had additional risk factors for hypercoagulability. Un-enhanced echocardiography was performed and revealed right ventricular (RV) dysfunction with a suspected RV mass. The use of bedside CE could confirm a RV thrombus in the first case and exclude it in the second case. Hence, anticoagulation therapy could be adjusted accordingly in both patients.

Discussion Coronavirus disease 2019 infection is associated with peripheral thrombo-embolism and cardiac thrombi. Given the critical condition of many patients affected by COVID-19, imaging for thrombo-embolic events is often restricted. With the use of bedside CE, cardiac masses may be correctly identified, aiding proper adjustment of anticoagulation therapy.

Keywords Cardiac mass • Cardiac thrombi • Contrast echocardiography • COVID-19 • Case series

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Learning points

- Coronavirus disease 2019 is associated with a coagulopathy and high rates of thrombo-embolic events.
- When a thrombus is suspected, it can be confirmed or refuted easily using bedside boluses of pre-activated contrast agents, facilitating appropriate management of patients.

Introduction

The current report describes two cases of right ventricular (RV) masses in patients admitted with coronavirus disease 2019 (COVID-19). Coronavirus disease 2019 patients are known to have high thrombotic risk.[1–6] An early and appropriate treatment of a suspected cardiac mass requires accurate diagnosis for implementing appropriate management. Thus, this report demonstrates the usefulness of contrast echocardiography (CE), a rapid bedside technique, as a part of the diagnostic workup in evaluating cardiac masses in COVID-19 patients.

Timeline Case 1

Day 1	• Admission with progressive coronavirus disease 2019 (COVID-19) pneumonia and type 1 respiratory failure, requiring non-invasive ventilation.
Day 4	• Transferred to another hospital for extra-corporeal membrane oxygenation (ECMO). Computed tomography with pulmonary angiography showed pulmonary embolism. Un-enhanced echocardiography showed RV strain. Therapeutic dose of anticoagulation therapy was started.
Day 20	• Decannulated from ECMO.
Day 30	• Transferred back to our hospital for rehabilitation.
Day 40	• Echocardiography was requested due to noted persistent tachycardia, which showed a persistently dilated and dysfunctional right ventricular (RV) with a probable RV mass. Contrast echocardiography showed an avascular mass, likely to be thrombus in this clinical scenario. Anticoagulation therapy was continued extending to 6 months with reassessment of the RV mass by echocardiography after his discharge.
Day 58	• Patient continued to improve and discharged.
Day 155	• A follow-up echocardiography was done: RV radial function normalized (fractional area change (FAC) = 38%), normal RV longitudinal systolic function, Apart from RV trabeculae, no mass or thrombi could be seen and confirmed by low MI contrast enhancement.

Timeline Case 2

Day 1	• Patient known with progressive lymphoma, admitted with COVID-19 pneumonia, type 2 respiratory failure, and left-sided pleural effusion, requiring non-invasive ventilation and left-sided drain.
Day 10	• Echocardiography was requested due to persistent tachycardia and shortness of breath and showed a suspected RV thrombus which was excluded by bedside contrast echocardiography. Only prophylactic doses of anticoagulation were initiated, avoiding any additional risk of bleeding.
Day 15	• Patient was tested COVID-19 negative, continued admission for treatment of his lymphoma.
Day 30	• Computed tomography with pulmonary angiography was done as a part of his malignancy workup and interestingly shows no evidence of pulmonary thrombi.

Case presentation

Case 1

A 35-year-old male with no medical co-morbidities [height: 178 cm, weight: 73 kg, body mass index (BMI): 23 kg/m^2, peak D-dimer: 4310 mcg/mL, Troponins: 24 and 20 ngm/L-no significant change] was admitted to intensive care unit (ICU) with severe COVID-19 pneumonitis. On examination, he was febrile, tachycardic, tachypnoeic [respiratory rate (RR)]: 46/min, borderline blood pressure (BP): 93/60 mmHg, and O_2 saturation: 82% on room air. Initial management with non-invasive ventilation progressed to invasive mechanical ventilation; however, his condition deteriorated and required his transfer for extra-corporeal membrane oxygenation (ECMO). Computed tomography with pulmonary angiography (CTPA) showed subsegmental pulmonary embolism with left lower lobe infarction. Initial echocardiography demonstrated RV dysfunction. Following his transfer back to our hospital for rehabilitation in the ICU, further unenhanced echocardiography was performed in the ICU due to persistent tachycardia. The echocardiographic images were compromised by patient's immobility though left ventricular (LV) was well visualized. Left ventricular size and function were normal; [LV ejection fraction (LVEF) = 55–60%] with normal LV filling

pressure. However, RV remained dilated (visually assessed in short axis) and impaired (fractional area shortening: 23%) with possible RV mass (*Figure 1A1*; *Video 1*). Bedside CE using IV boluses of pre-activated Luminity of 0.3 mL (Perfluoropropane lipid microsphere; Bristol-Myers Squibb) (Philips EPIQ CVx scanner, using low mechanical index <0.14) showed a non-perfused RV mass (*Figure 1A2*, *Videos 2* and *3*). The differential diagnosis for poorly perfused cardiac masses includes stromal tumours and thrombi, with thrombus most likely in this clinical scenario. On this basis, anticoagulation therapy was extended for up to 6 months with request for a reassessment of the RV thrombus after patient's discharge. Four months later, follow-up echocardiography was performed after about 3 months of patient's discharge and revealed resolution of RV mass, confirmed by CE (Supplementary material online, *Video S1*) with normalization of RV function (fractional area shortening = 38%).

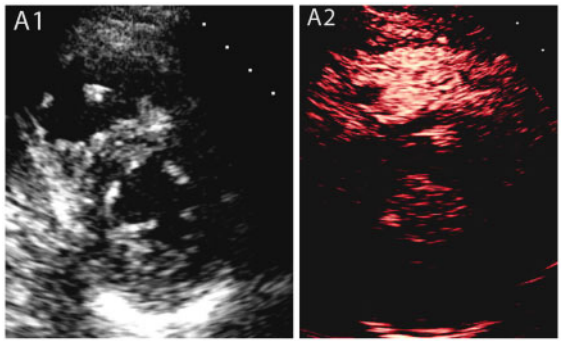


Figure 1 Case 1: A male coronavirus disease 2019 patient who had a previous pulmonary embolism with a suspected right ventricular thrombus in the non-enhanced study, which was subsequently confirmed by contrast echocardiography. (*A1*) Parasternal short axis view shows a small right ventricular mass, (*A2*) contrast echocardiography of the same view, showing a non-perfused right ventricular mass suggestive of thrombus.

Case 2

A 55-year-old male with a history of chronic obstructive pulmonary disease (COPD), schizophrenia, epilepsy and progressive lymphoma on chemotherapy (height: 169 cm, weight: 52 kg, BMI: 18.2 kg/m^2, peak D-Dimer: 1220 mcg/mL, Troponins: 22 and 25 ngm/L-no significant change) was admitted to the high dependency unit (HDU) with COVID-19 pneumonia, recurrent left-sided pleural effusion and type 2 respiratory failure. On examination, he was febrile, tachycardic, tachypnoeic [(RR): 28/min], O_2 saturation: 62% on room air and his BP was 123/63 mmHg. He had left-sided chest drain inserted for his pleural effusion and required prolonged non-invasive ventilation. Persistent tachycardia and shortness of breath prompted an unenhanced echocardiogram in the HDU demonstrating, LV size and function were normal (LVEF: 60%) with normal LV filling pressure, significant RV dilatation (basal diameter: 4.5 cm) and dysfunction (fractional area shortening = 25%), high pulmonary vascular resistance and probable thrombus in the RV (*Figure 1B1, B2*, Supplementary material online, *Videos S2–S4*). However, bedside CE performed both to improve image quality which was poor and to characterize the RV mass revealed the mass to be a conglomeration of trabeculation with contrast moving between trabeculae-masquerading as a mass on unenhanced

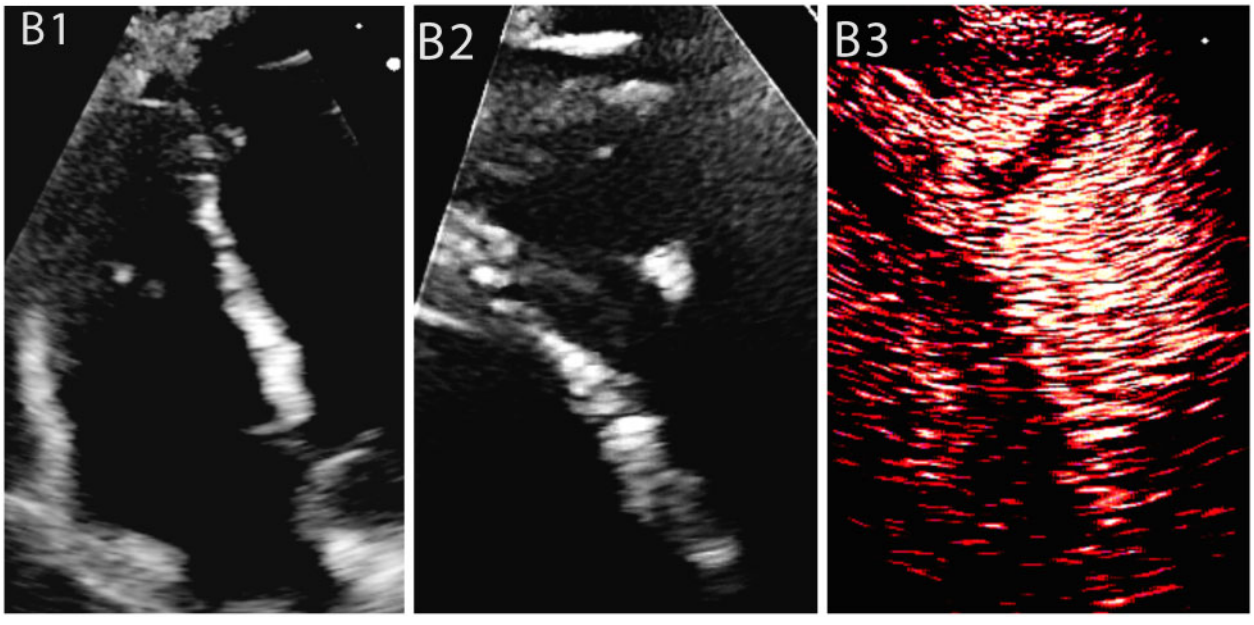
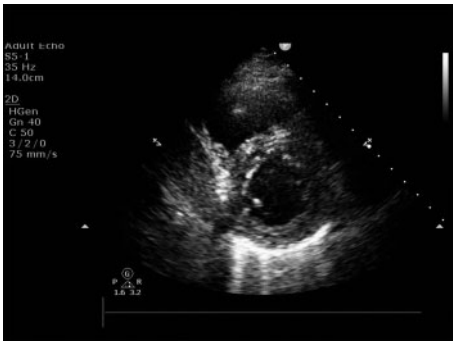
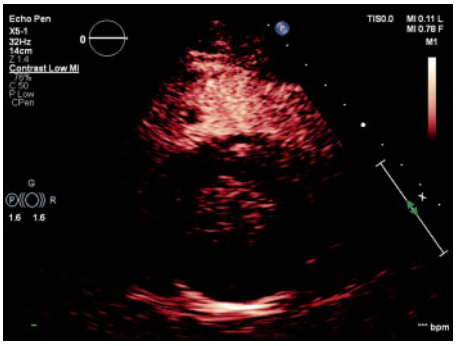


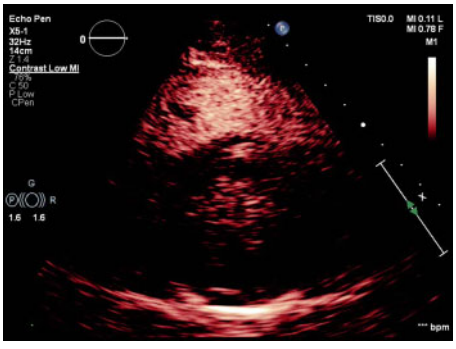
Figure 2 Case 2: A male COVID-19 patient with lymphoma on chemotherapy. Non-contrast study showed a dilated and dysfunctional RV with elevated PVR and a suspected RV thrombus which was identified as RV trabeculation on CE. (*B1*) Non-enhanced image of a dilated and dysfunctional RV, (*B2*) Non-enhanced image of RV modified view displays an apical mass, (*B3*) CE of RV modified view demonstrates no evidence of mass but a conglomerate of trabeculation with contrast noted between the trabeculae.



Video 1 Non-enhanced echo showed a suspected RV mass, parasternal short axis view.



Video 2 Contrast enhanced echo confirmed RV non-perfused mass likely thrombus, parasternal short axis view.



Video 3 Contrast enhanced echo confirmed RV non-perfused mass likely thrombus, parasternal short axis view.

echocardiography. Therefore, unnecessary anticoagulation was avoided (*Figure 1B3*, Supplementary material online, *Video S5*). Interestingly, a CTPA was done later as a part of his progressive lymphoma workup and showed no evidence of pulmonary embolism.

Discussion

It is known that there is a significantly high incidence of both arterial and venous thrombotic events in critically ill patients with COVID-19.[1–6] Thus, the threshold for the commencement of therapeutic anticoagulation is low in COVID-19. However, when a diagnosis of a thrombus is uncertain, over-treatment with therapeutic doses of anticoagulation may cause an unwanted increased risk of bleeding especially in septic patients, and under-treatment may result in catastrophic embolization. Therefore, it is important to establish a diagnosis of thrombus promptly in COVID-19 patients with suspected cardiac masses.

Two-dimensional echocardiography remains the imaging technique of choice in COVID-19 patients because it can be performed at the bedside and can assess cardiac structure and function rapidly. However, unenhanced echocardiography cannot distinguish thrombus from other cardiac masses. While the probability of thrombus is high in COVID-19 patients with suspected cardiac masses, especially with cardiac dysfunction, it is desirable to have an accurate diagnosis for appropriate management of patients. Echocardiographic contrast perfusion imaging which is performed at the bedside has been recommended to distinguish thrombus from other cardiac masses.[7–9] Thrombus shows complete lack of perfusion. The first case showed that the suspected mass was indeed a thrombus as there was no contrast uptake. Another differential diagnosis for poorly perfused cardiac masses includes stromal tumours, but the clinical scenario of this patient made a diagnosis of thrombus most likely and allowed appropriate adjustment of the anticoagulation regimen. In the second case, CE refuted the diagnosis of a mass when contrast could be seen travelling between strands of tissues (the conglomerated trabeculae gave an appearance of a mass in unenhanced images). This prevented unnecessary institution of anticoagulation with high bleeding risk in COVID-19 patients. The first patient appeared to have a higher predisposition for thrombo-embolic phenomenon as he had more severe inflammatory response (approximately four folds higher D-dimer compared to the second case and was on ECMO).

The only contraindication of CE is known allergy against the contrast agent. If not present, CE has been found to be safe in the acute care setting including patients with acute respiratory distress syndrome.[10] The CE needs to be performed and interpreted by the staff trained specifically in CE.

Conclusions

COVID-19 infection is associated with a hypercoagulable state with a high incidence of thrombo-embolic events. This report provides examples of the additive value of bedside CE in the investigation of suspected RV cardiac thrombi in COVID-19 patients, encouraging its wider use where appropriate.

Lead author biography

Christina Botrous MBBS, MSC, graduated in Medicine in Egypt in 2012. Currently, she is working as a cardiac research fellow in Northwick Park Hospital. She has special interest in clinical cardiology and non-invasive cardiovascular imaging.

Supplementary material

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

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

Consent: Patients have given a written consent for submission and publication of this case series including images and associated text has been obtained from the patients in line with COPE guidance.

Conflict of interest: R.S. was given speaker fees by Bracco (Milan, Italy), Lantheus Medical Imaging (Boston, Massachusetts) and Philips Healthcare (Eindhoven, Holland). Other authors declare no conflicts of interest to disclose.

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