

# Percutaneous thrombectomy and right ventricular mechanical circulatory support for pulmonary embolism in a coronavirus disease 2019 patient: case report, 1-year update, and echocardiographic findings

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## Background

We previously described percutaneous thrombectomy and right ventricular (RV) mechanical support of a coronavirus disease 2019 (COVID-19) patient with a massive pulmonary embolism. Here, we present a detailed echocardiographic and clinical timeline with 1-year follow-up.

## Case summary

A 57-year-old female with COVID-19 went into shock from a massive pulmonary embolism. After percutaneous removal of a large thrombus burden (AngioVac system; AngioDynamics Inc., Latham, NY, USA), she became severely hypotensive, requiring cardiopulmonary resuscitation, and hemodynamic support with an Impella RP device (Abiomed, Danvers, MA, USA). A paediatric transoesophageal echocardiography (TOE) probe monitored the procedure because an adult probe would not pass (S7-3t—Philips Medical Systems, Andover, MA, USA). Post-thrombectomy, surface imaging documented gradual resolution of RV dysfunction, tricuspid regurgitation, and elevated pulmonary artery pressure. Her course was complicated by renal failure requiring temporary dialysis. She was discharged home on apixaban. Hypercoagulability work-up was negative. Two months later, vocal cord surgery was performed for persistent stridor. Esophagoscopy at that time was prevented by osteophyte obstruction. At 10 months, she received the Pfizer-BioNTech vaccine. At 1 year, the patient remains healthy on apixaban, and her echocardiogram is normal.

## Discussion

This case illustrates the pivotal role of echocardiography in the diagnosis, percutaneous treatment, and near- and long-term follow-up and management of a patient with massive pulmonary embolism due to COVID-19 with documentation of complete recovery from severe RV dysfunction and haemodynamic collapse. A paediatric TOE probe was a crucial alternative to the adult probe because of possible osteophyte obstruction.

## Keywords

Case report • COVID-19 • Pulmonary embolism • Thrombectomy • Mechanical circulatory support • Echocardiography • Paediatric transoesophageal echocardiography probe

## ESC Curriculum

2.2 Echocardiography • 6.7 Right heart dysfunction • 9.5 Pulmonary thromboembolism • 7.2 Post-cardiac arrest

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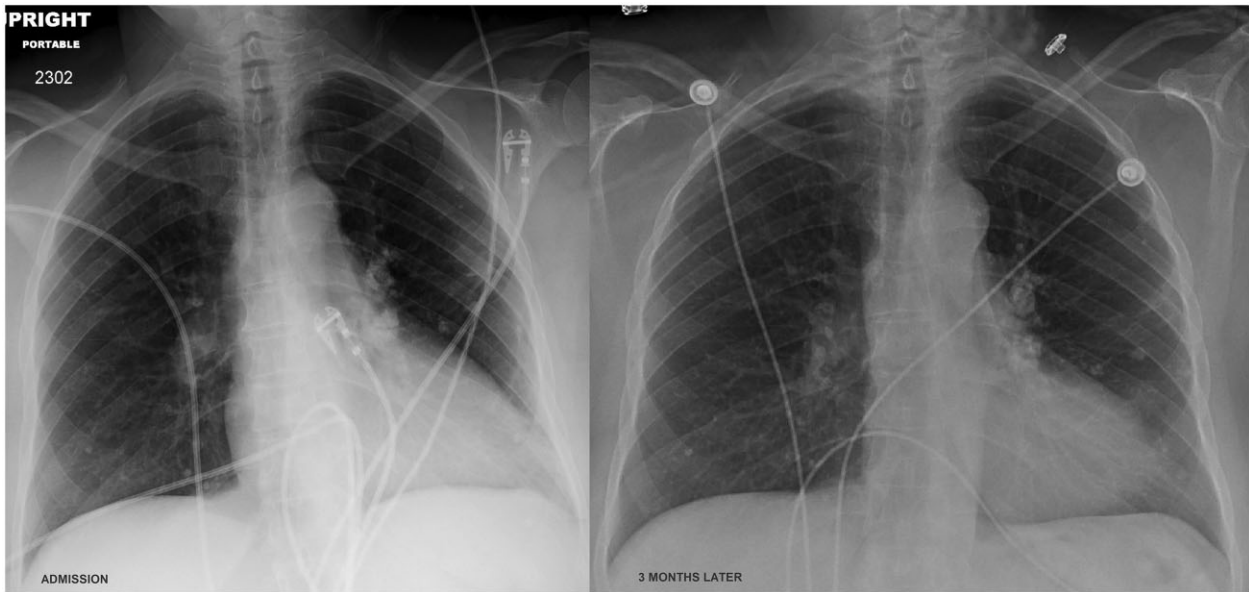
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## Learning points

- Percutaneous thrombectomy and mechanical circulatory support guided by echocardiography can lead to complete clinical and cardiac recovery after massive pulmonary embolism and coronavirus disease 2019.
- Echocardiographic imaging with a paediatric transoesophageal echocardiography probe may be able to guide cardiac interventions when an adult probe cannot be inserted.



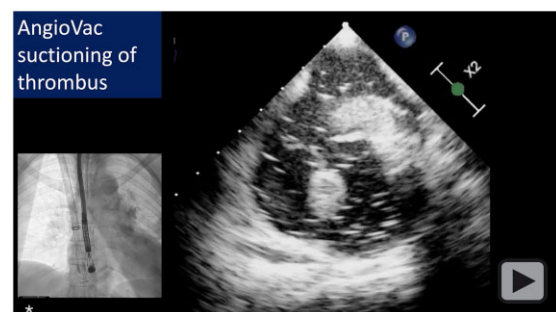
**Figure 1** No lung space disease is evident on admission portable Anterior Posterior (left) and 3-month post-discharge Posterior Anterior (right) chest X-rays aside from old granulomatous changes. Pulmonary artery truncation was present with peripheral oligemia on admission that resolved on follow-up.

## Introduction

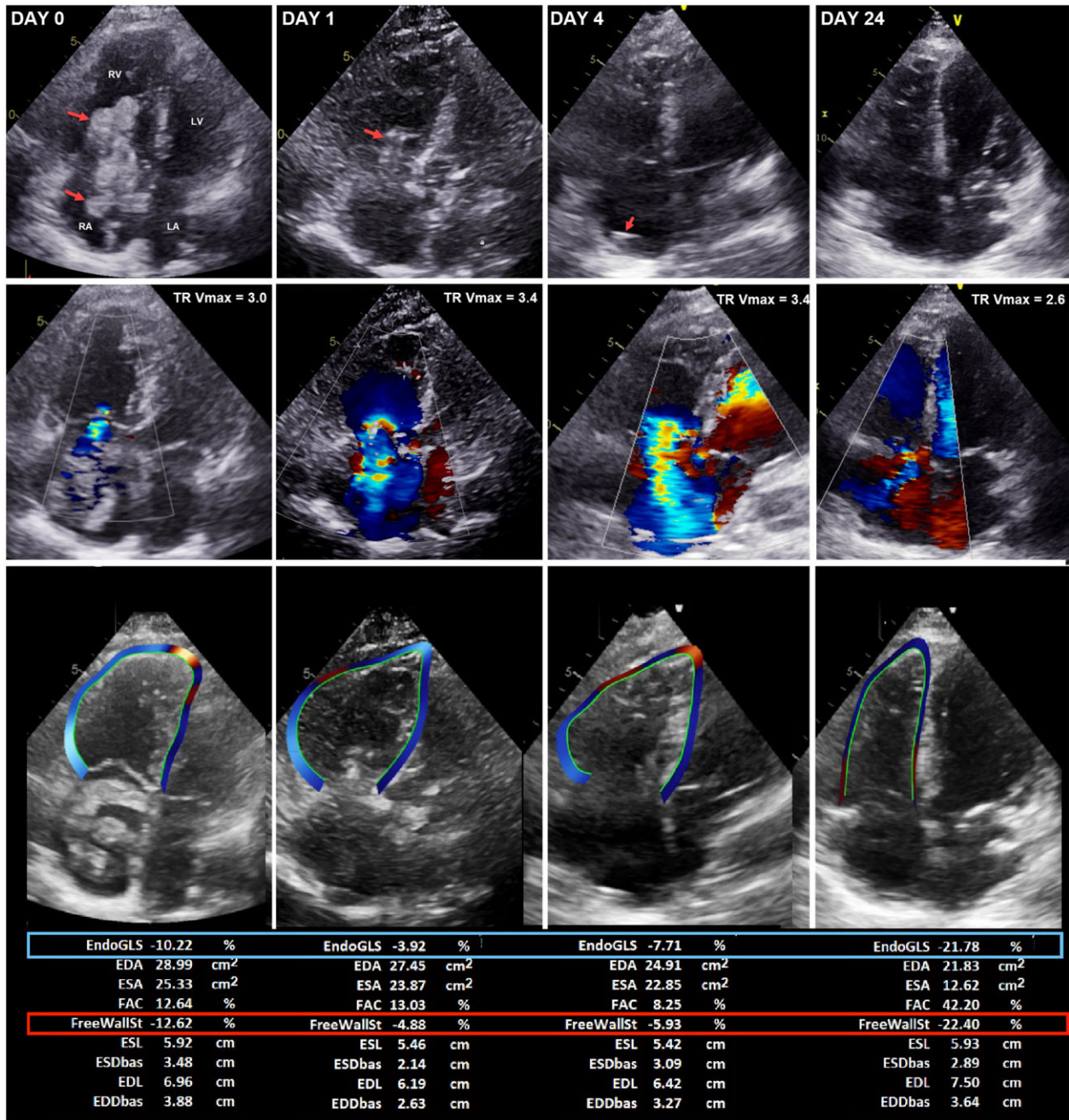
Patients with coronavirus disease 2019 (COVID-19) are at risk for venous thrombosis and potentially massive, pulmonary embolism (PE).<sup>1–2</sup> We previously described the use of an Impella RP (Abiomed, Danvers, MA, USA) device to resuscitate a patient after a bulky right heart embolism was removed using an AngioVac system (AngioDynamics Inc., Latham, NY, USA).<sup>1</sup> The case contributed to the Food and Drug Administration emergency use authorization of the Impella RP in this setting. Here we present the echocardiographic timeline and 1-year update and discuss the utility of a paediatric transoesophageal echocardiography (TOE) probe that was needed in this case.

## Case recap

A 57-year-old African American female with a history of asthma and left knee arthritis had 1 week of fever, diarrhoea, left leg swelling, and dyspnoea culminating in her call to Emergency Medical Services. On arrival, she was tachycardic and hypotensive in



**Video 1** A video timeline that includes the clinical summary (\*), chest X-ray, electrocardiogram (\*), pulmonary angiogram (\*), baseline and follow-up 2D, colour Doppler, and strain transthoracic echo echocardiography, transoesophageal echocardiography at baseline, during AngioVac aspiration of thrombus and changes before and during Impella RP insertion with blood pressure monitor measurements (\*) and images of the thrombus during and after extraction from the AngioVac catheter (\*). (Asterisk indicates reproduction from reference 1 under its Creative Commons CC-BY-NC license).



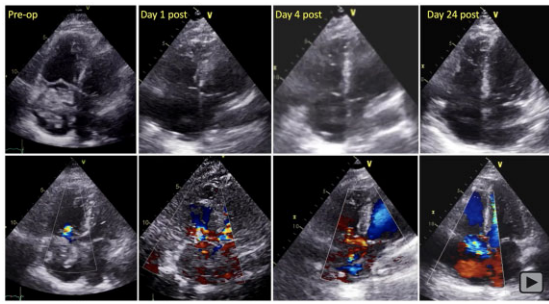
**Figure 2** Transthoracic apical four-chamber images at baseline and follow-up. Day 0 images show a large thrombus in transit (arrows) with right atrial and right ventricular dilation, small left atrial and left ventricular sizes, and mild tricuspid regurgitation. Day 1 images continue to show right atrial and right ventricular dilation and decreased left atrial and left ventricular sizes and severe tricuspid regurgitation and the Impella RP (arrow). Day 4 shows improved left atrial and left ventricular filling and severe tricuspid regurgitation after removal of the Impella RP. Arrow points to a dialysis catheter. Day 24 images show improved right atrial and right ventricular dilation, improved left atrial and left ventricular filling, and mild tricuspid regurgitation. Strain and dimension indices were abnormal at baseline and worse after AngioVac removal of the thrombus, despite Impella RP support. Strain is slightly improved on Day 4 though dimension indices are unchanged. Recovery in right ventricular dilation and dysfunction has occurred at day 24.

severe respiratory distress. Lung fields were clear, and the left lower extremity was oedematous. A surface echo showed a massive thrombus in transit in the right atrium and severe right ventricular (RV) dysfunction with a McConnell sign. Chest X-ray did not show pneumonia (Figure 1). Pulmonary angiography diagnosed

a massive PE. Nasopharyngeal Polymerase Chain Reaction test was positive for COVID-19.

Clinical shock prompted preparation for AngioVac (Generation 2) aspiration thrombectomy with TOE guidance. Multiple attempts to pass an adult TOE probe were unsuccessful which was attributed to





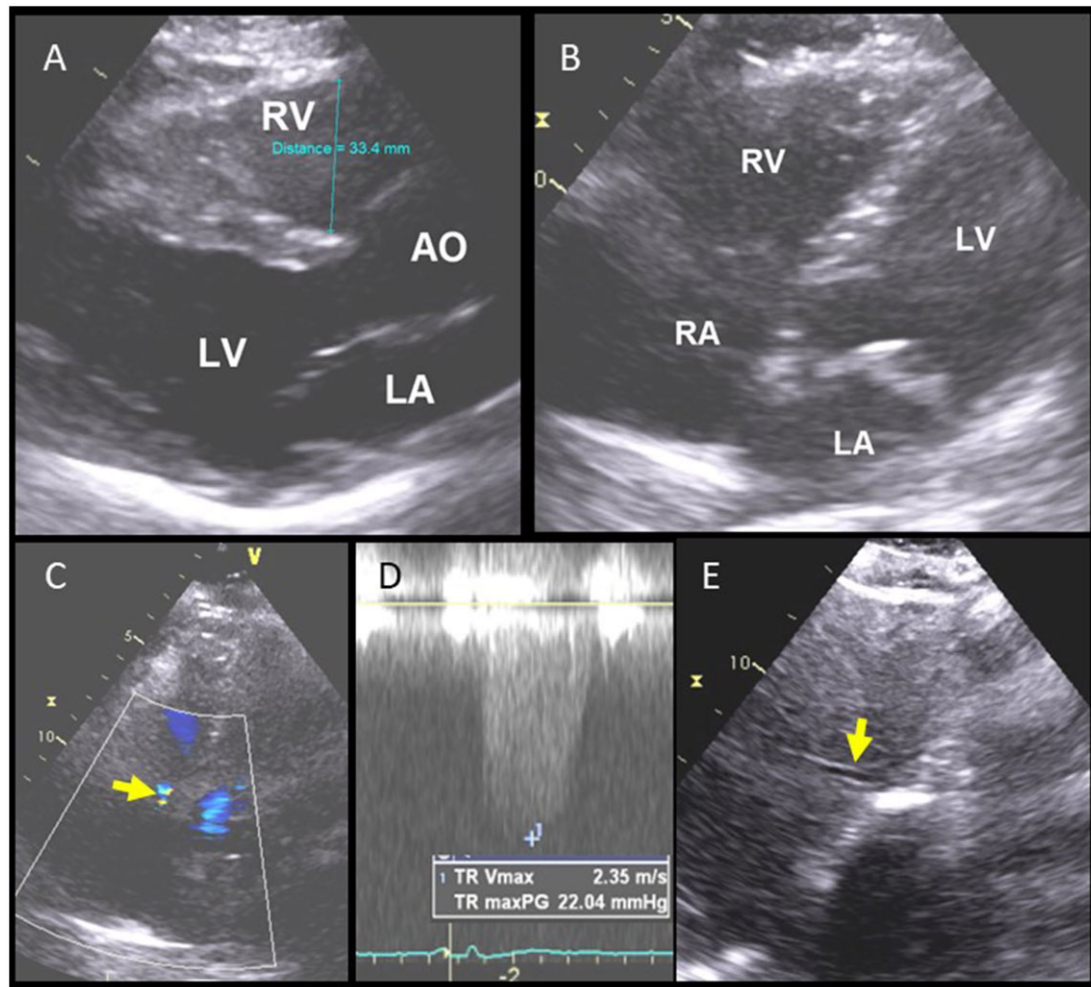
**Video 2** Apical four-chamber views that show the changes in chamber sizes and function and in tricuspid regurgitation before thrombectomy and at Days 1, 4, and 24 post-thrombectomy. The size and function of the right ventricle by 2D and strain imaging are very abnormal in the perioperative period and normalize by Day 24.

the positioning of the endotracheal tube. Instead, a paediatric TOE probe (S7-3t—Philips Medical Systems, Cambridge, MA, USA) was inserted despite some initial resistance. Profuse oropharyngeal bleeding followed.

The paediatric probe generated good images that monitored AngioVac removal of the right atrial (RA) thrombus. Subsequently, the RV became akinetic and severe hypotension required cardiopulmonary resuscitation (CPR). A stable blood pressure was restored with pressors and Impella RP support and she was transferred to the Intensive Care Unit. Post-operative oropharyngeal evaluation revealed no source of bleeding (*Video 1*).

## Further follow-up

The patient had a complicated course due to initial shock with acute kidney injury necessitating 2 weeks of haemodialysis. She was anticoagulated with full dose IV heparin which was changed to argatroban



**Figure 3** One-year follow-up transthoracic images show normal end-diastolic cardiac dimensions with upper normal right ventricular size on parasternal (A) and sub-costal (B) imaging, trivial tricuspid regurgitation (yellow arrow) on a technically limited apical four-chamber view (C), normal pulmonary artery systolic pressure (D), and a collapsed inferior vena cava (yellow arrow) (E).

12 days later because of heparin induced thrombocytopenia and renal dysfunction. Five 5 days after admission, she was extubated.

Transthoracic echocardiograms during the recovery period showed gradual, post-operative improvement in RV dysfunction and dilation, tricuspid regurgitation (TR), and left ventricular and left atrial filling (Video 1). TomTec (TomTec Imaging Systems, Unterschleissheim, Germany) software showed improvement in RV strain after an initial post-procedural drop (Figure 2, Video 2).

Three weeks after presentation, her recovery and improving renal function enabled discharge to home care on apixaban 5 mg twice a day. She continued to recover except for dysphonia and stridor which was relieved 2 months later when laryngoscopy guided debridement of granulation tissue pressing on a vocal fold. Flexible oesophagoscopy at that time was unsuccessful which was attributed to osteophytes viewed on helical computed tomography.

Ten months after discharge, she completed two doses of the Pfizer/BioNTech COVID-19 vaccine. A work-up for hypercoagulability was negative. Chest x-rays were normal except for old granulomatous disease (Figure 1). At 1-year follow-up, the patient remains on apixaban and is healthy and active except for mild limitation from knee arthritis. Transthoracic echocardiography showed normal chamber sizes, normal biventricular systolic and diastolic function, including RV strain, trivial TR, and normal pulmonary artery systolic pressure (Figure 3).

## Discussion

Critically ill COVID-19 patients are at high risk of thrombotic complications such as pulmonary embolism.<sup>1,2</sup> Therapeutic options include anticoagulation, thrombolysis,<sup>3</sup> surgical or aspiration thrombectomy,<sup>4</sup> and haemodynamic support. The Impella RP is an option that enables rapid resuscitation, which was lifesaving in our patient.<sup>1</sup> Its application for RV failure was first described in 2014 for patients without PE and in 2018 in patients with shock from PE.<sup>5-7</sup>

Our report documented resilient improvement in RV function. After extraction of a large amount of thrombus, some residual thrombus may have dislodged to occlude the already severely obstructed pulmonary vasculature causing haemodynamic collapse from RV akinesis that was promptly recognized on TOE.<sup>8</sup> Despite this dramatic presentation and course, our case documents the rescue of our patient from near-death by combining thrombus extraction and RP Impella support with restoration of her health, both clinically and on echo, with normal pulmonary artery pressure at 1 year.

We describe the role of the paediatric TOE probe, which by its smaller size, may enable intubation when the adult probe cannot be inserted. This advantage may be lifesaving in critically ill or arresting patients with an obstructing pharynx. In our patient, obstruction was originally attributed to the endotracheal tube placement, but post-discharge work-up indicated osteophytes as a cause.<sup>9</sup> Downsides of the paediatric probe include reduced image quality, single knob manipulation, and lack of 3D imaging.<sup>10</sup> However, new advances combine miniaturization with improved image quality. In our patient, these improvements enabled guidance of the AngioVac procedure, detection of haemodynamic collapse, and Impella RP resuscitation monitoring.

## Lead author biography



Gerald Cohen MD is a graduate of McGill University and director of echo labs for 30 years. Currently, he directs noninvasive cardiology, interventional echocardiography, and cardiac rehabilitation at Ascension St. John Hospital in Detroit, Michigan. He is also a clinical professor of medicine at Wayne State University. In addition to the above, special interests include high reso-

lution atherosclerosis ultrasound imaging and novel applications of software in medicine.

**Conflict of interest:** A.K.: Abiomed Inc., Inari Medical. G.I.C., T.S., and H.S.: no relevant disclosures.

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**Consent:** The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

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