Percutaneous thrombectomy and right ventricular mechanical circulatory support for pulmonary embolism in a COVID-19 patient: Case report, one-year update, and echocardiographic findings.

Gerald I. Cohen, MD  
Theodore Schreiber, MD  
Hemindermeet Singh MD  
Amir Kaki, MD

Division of Cardiology.  
Department of Internal Medicine,  
Ascension St. John Hospital and Medical Center (*)  
Detroit, MI

Division of Cardiology, 22101 Moross Road, Detroit, MI 48236

Contact:  
Email: gerald.cohen@ascension.org  
Tel. 313 343-4216

Conflict of Interest:  
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Abstract:

Background: We previously described percutaneous thrombectomy and right ventricular mechanical support of a 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 CPR, and was resuscitated with an Impella RP device (Abiomed, Danvers, MA, USA). A pediatric TEE 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 right ventricular 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 one 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 right ventricular dysfunction and hemodynamic collapse. A pediatric TEE 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, pediatric transesophageal echocardiography probe
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**Affiliations:**

Gerald I. Cohen, MD,
Theodore Schreiber, MD
Amir Kaki, MD

are affiliated with Ascension St. John Hospital, Detroit, MI.

Hemindermeet Singh MD is affiliated with
Mercy-Health St. Vincent Medical Center Toledo, OH

**Contributions:**

All authors were directly involved in the patient’s care and data acquisition and interpretation. All authors have given final approval of the version to be published and agree to be accountable for all aspects of the work.

Dr. Cohen is an echo-cardiologist who performed the TEE imaging, interpreted the transthoracic echocardiograms, post-processed the surface images to derive right ventricular strain, wrote the manuscript, designed the figures and videos, and administered the submission.

Drs. Schreiber, Kaki, and Singh are interventional cardiologists who performed the percutaneous interventions, obtained fluoroscopic images, and made substantial contributions to the drafting and design of the manuscript.
Learning Points:

Percutaneous thrombectomy and mechanical circulatory support guided by echocardiography can lead to complete clinical and cardiac recovery after massive pulmonary embolism and COVID-19.

Echocardiographic imaging with a pediatric TEE probe may be able to guide cardiac interventions when an adult probe cannot be inserted.
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Percutaneous thrombectomy and right ventricular mechanical circulatory support for pulmonary embolism in a COVID-19 patient: Case report, one-year update, and echocardiographic findings.

Introduction:

Patients with COVID-19 are at risk for venous thrombosis and potentially massive, pulmonary embolism (PE) (1-2). 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) (1). The case contributed to the FDA emergency use authorization of the Impella RP in this setting. Here we present the echocardiographic timeline and one-year update and discuss the utility of a pediatric TEE 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 one week of fever, diarrhea, left leg swelling, and dyspnea culminating in her call to EMS. On arrival, she was tachycardic and hypotensive in severe respiratory distress. Lung fields were clear, and the left lower extremity was edematous. A surface echo showed a massive thrombus in transit in the right atrium and severe RV dysfunction with a McConnell sign. Chest x-ray did not show pneumonia (Figure 1). Pulmonary angiography diagnosed a massive PE. Nasopharyngeal PCR was positive for COVID-19.

Clinical shock prompted preparation for AngioVac (Generation 2) aspiration thrombectomy with TEE guidance. Multiple attempts to pass an adult TEE probe were unsuccessful which was attributed to the positioning of the endotracheal tube. Instead, a pediatric TEE probe (s7-3t - Philips Medical Systems, Cambridge, MA, USA) was inserted despite some initial resistance. Profuse oropharyngeal bleeding followed.
The pediatric probe generated good images that monitored AngioVac removal of the RA thrombus. Subsequently, the RV became akinetic and severe hypotension required CPR. A stable blood pressure was restored with pressors and Impella RP support and she was transferred to the ICU. 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 hemodialysis. She was anticoagulated with full dose IV heparin which was changed to argatroban 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, TR, and LV and LA filling (Video 1). TomTec (TomTec, 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 esophagoscopy at that time was unsuccessful which was attributed to osteophytes viewed on helical CT.

Ten months after discharge, she completed 2 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 one 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 (1-2). Therapeutic options include anticoagulation, thrombolysis (3), surgical or aspiration thrombectomy (4), and hemodynamic support. The Impella RP is an option that enables rapid resuscitation, which was lifesaving in our patient (1). Its application for RV failure was first described in 2014 for patients without PE and in 2018 in patients with shock from PE (5-7).

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 hemodynamic collapse from RV akinesis that was promptly recognized on TEE (8). 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 pediatric TEE 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 (9). Downsides of the pediatric probe include reduced image quality, single knob manipulation, and lack of 3D imaging (10). However, new advances combine miniaturization with improved image quality. In our patient, these improvements enabled guidance of the AngioVac procedure, detection of hemodynamic collapse, and Impella RP resuscitation monitoring.
References:


**Figure Legends:**

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

Figure 2: Transthoracic apical 4-chamber images at baseline and follow-up. Day 0 images show a large thrombus in transit (arrows) with RA and RV dilation, small LA and LV, and mild TR. Day 1 images continue to show RA and RV dilation and decreased LA and LV and severe TR and the Impella RP (arrow). Day 4 shows improved LA and LV filling and severe TR after removal of the Impella RP. Arrow points to a dialysis catheter. Day 24 images show less RA/RV dilation, improved LA/LV filling, and mild TR. 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. Complete recovery in RV dilation and dysfunction has occurred at 24.

Figure 3: One year follow-up transthoracic images show normal end-diastolic cardiac dimensions with upper normal RV size on parasternal (A) and subcostal (B) imaging, trivial tricuspid regurgitation on a technically limited apical 4-chamber view (C), normal pulmonary artery systolic pressure (D), and a collapsed IVC (E).
Video Legends:

Video 1: A video timeline that includes clinical summary (*), Chest X-ray, EKG (*), pulmonary angiogram (*), baseline and follow-up 2D, color Doppler and strain transthoracic echo echocardiography, transesophageal 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)

Video 2: Apical 4 chamber views that show the changes in chamber sizes and function and in tricuspid regurgitation before thrombectomy and at day 1, 4, and 24 post thrombectomy. The size and function of the RV by 2D and strain imaging are very abnormal in the perioperative period and normalize by day 24.

Patient consent statement:
The authors have obtained written patient consent in accordance with COPE guidelines.