

# Massive Pulmonary Embolism Treated with Catheter Therapy and Extracorporeal Membrane Oxygenation

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## ABSTRACT

Massive pulmonary embolism (PE) is associated with significant morbidity and mortality. Treatment for massive PE can include systemic thrombolysis and catheter-directed therapy. We present the case of a patient with massive PE successfully treated with catheter-directed therapy, using extracorporeal membrane oxygenation for hemodynamic support, and discuss some of the potential complications associated with this therapy.

## INTRODUCTION

Pulmonary embolism (PE) is a major cause of mortality and morbidity. More than 500,000 cases of venous thromboembolism (VTE) occur in the United States annually, and the mortality rate ranges from 8.1% to 65%, depending on severity [Kuo 2009; Jaff 2011]. Massive PE is defined as acute PE with sustained hypotension and is associated with a greater than 50% 90-day mortality [Jaff 2011].

Systemic thrombolysis is the standard of care for massive PE but is limited by bleeding risk and time to effect [Kuo 2009]. The disadvantages of systemic thrombolysis have led to the use of catheter-directed therapy (CDT), particularly for patients with PE and concurrent hemodynamic instability. We describe the successful treatment of massive PE via CDT in a patient requiring extracorporeal membrane oxygenation (ECMO) for hemodynamic support.

## CASE REPORT

A 36-year-old male with a history of rectal adenocarcinoma with liver metastases status-post proctocolectomy and hepatic lobectomy was admitted for management of persistent bile leak. On hospital day 4, he became tachycardic, hypotensive, and hypoxic. Given the concern for PE, heparin was administered while awaiting computed tomographic-pulmonary angiography (CTPA), which revealed near-occlusive PE in the left and right pulmonary arteries (PAs) with extension of

embolus from the right PA into the main PA (Figure 1). Also noted was enlargement of the right ventricle (RV) and right atrium (RA) with flattening of the intraventricular septum (Figure 2). Transthoracic echocardiogram (TTE) showed severe RV dilation, significant reduction in ejection fraction, and abnormal septal motion.

The patient was taken to the hybrid operating room for endovascular pulmonary thromboembolectomy with contingency for ECMO support. In anticipation of possible venoarterial (V-A) ECMO, 5-French introducer sheaths were placed under ultrasound (US) and fluoroscopic guidance into the left common femoral artery and vein. Intraoperative pulmonary arteriogram was performed, confirming near-occlusive thrombus in the right PA, occlusive thrombus in the left PA, and significant RV dilation.

During the procedure, the patient had persistent hypoxia and the decision was made to proceed with V-A ECMO. Using Seldinger technique, the femoral arterial and venous sheaths were converted to 19-French and 25-French ECMO cannulae, respectively. Correct positioning of the cannulae was confirmed with fluoroscopy, and ECMO support was initiated.

Combined suction and rheolytic thrombectomy was then performed with the Penumbra suction catheter (Penumbra,

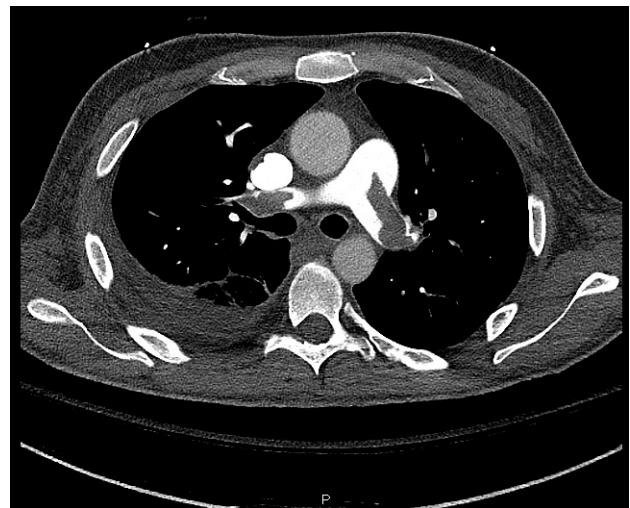


Figure 1. Computed tomographic-pulmonary angiography (CTPA) showing large, near-occlusive emboli in the left and right pulmonary arteries.

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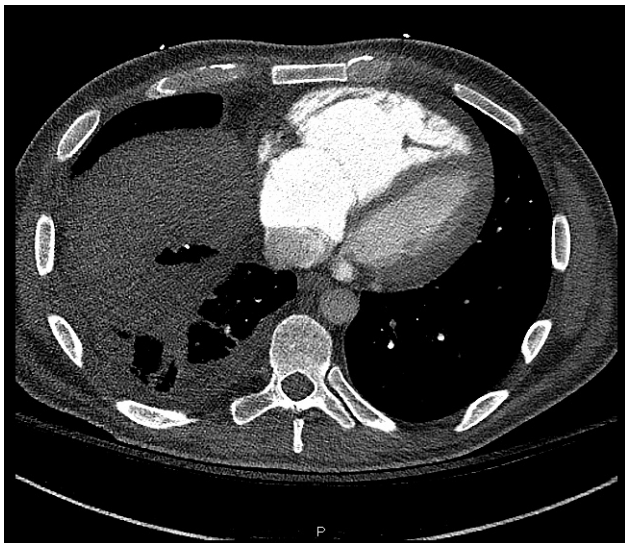


Figure 2. CTPA showing right heart enlargement and flattening of the intraventricular septum.



Figure 3. Non-contrast head CT showing large subacute infarction in a right posterior cerebral artery distribution.

Alameda, CA, USA) and AngioJet (Boston Scientific, Natick, MA, USA) systems, respectively. There was significant reduction in clot burden with subsequent improvement in oxygenation and hemodynamics. A suprarenal inferior vena cava (IVC) filter was also placed.

The patient's left foot was noted to be cool and pale with diminished pulses. An 8-French perfusion cannula was placed percutaneously into the left superficial femoral artery (SFA) under ultrasound guidance. The perfusion cannula was connected to the arterial limb of the ECMO circuit. The left foot improved in warmth and color, and pulses were again detectable on Doppler ultrasound. Of note, the patient also developed red-colored urine post-procedure, which resolved with hydration.

The patient's cardiac and respiratory function continued to improve, and he was successfully weaned from ECMO on postoperative day 2. A head CT was performed for possible seizure activity, which showed a large subacute infarct in the distribution of the right posterior cerebral artery (Figure 3). TTE with bubble study showed a patent foramen ovale (PFO) with right-to-left shunt. Ultimately, the patient was discharged home without any residual neurologic deficits.

## DISCUSSION

Catheter-directed therapy is increasingly used in the treatment of massive PE, particularly in patients who are not candidates for systemic thrombolysis. CDT comprises two modalities: mechanical removal of thrombus and directed administration of thrombolytic agent. In one of the largest published systematic reviews on CDT for management of massive PE, Kuo et al reported a high pooled clinical success rate of 86.5% in 594 patients treated with various CDT techniques [Kuo 2009]. The risks of major and minor complications were low at 2.4% and 7.9%, respectively [Kuo 2009].

AngioJet is one of the modalities used in CDT. The AngioJet catheter utilizes high-pressure saline jets to generate a vacuum via the Venturi-Bernoulli effect, allowing for maceration and evacuation of thrombus. This device has been shown to be successful in several small case series [Chechi 2009]. The precise role of CDT in the management pathway of acute PE remains unclear. There are several potential risks of CDT, including distal embolization of clot, vessel perforation, cardiac tamponade, pulmonary hemorrhage, contrast-induced anaphylaxis or nephropathy, bradycardia, and heart block [Brahmbhatt 2007].

Another potential complication of CDT, and specifically AngioJet, is hemolysis, which can result in hemoglobinuria. This can cause acute kidney injury due to acute tubular necrosis [Dukkipati 2009]. Our patient did develop hemoglobinuria following his procedure, but this was self-limited and had minimal clinical significance. It remains important for the clinician to recognize hemolysis as a potential cause of hemoglobinuria following use of the AngioJet device.

Our patient required ECMO support during the management of his PE. Data on the use of ECMO in patients with massive PE is limited to sporadic case reports and case series. A systematic review of these reports on ECMO for the management of acute massive PE found an overall survival rate of 70.5% in a sample of 78 patients [Yusuff 2015]. An important consideration in percutaneous femoral access for ECMO is lower-extremity acute limb ischemia. In a retrospective study of 43 patients with femoral arterial cannulae on ECMO, there were no cases of limb ischemia in patients with prophylactically placed SFA cannulae; 21% of patients without such cannulae did develop limb ischemia [Foley 2010]. Patients who developed limb ischemia were significantly younger than those who did not, presumably secondary to age-related expansion of arterial diameter and vascular collateralization [Foley 2010]. Our practice is to routinely place a prophylactic

distal perfusion cannula in the SFA. In this case, the patient did demonstrate signs of acute limb ischemia, which resolved with perfusion of the SFA.

Our patient also suffered an ischemic stroke, likely secondary to paradoxical embolism through a PFO. Konstantinides et al found 35% of 139 consecutive patients presenting with massive pulmonary embolism had a PFO. The presence of a PFO was an independent risk factor for hospital mortality (33% versus 14%) in those patients with RV overload or pulmonary hypertension. PE patients with PFO also had a higher incidence of ischemic stroke than those without PFOs (13% versus 2%) [Konstantinides 1998].

## CONCLUSION

Catheter-directed thrombolysis for the management of massive pulmonary embolism holds theoretical benefits over standard therapy with systemic administration of thrombolytic agents. We recommend that CDT be performed in centers that have ECMO capability to provide support in the event of cardiopulmonary collapse.

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