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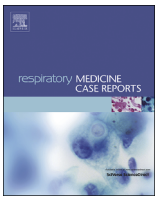

Case Report

# Detection of right atrial thrombus in a woman with pulmonary embolism and right heart compromise by bedside echocardiography

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ABSTRACT

A 59-year-old female with a history of stage IV lung adenocarcinoma presented with worsening shortness of breath and cough over several weeks. She was tachycardic, hypotensive, and tachypneic. Portable chest x-ray suggested bilateral pleural effusions and computed tomography angiography (CTA) revealed bilateral pulmonary emboli (PE) with suspected right heart strain. Upon admission to the medical intensive care unit for treatment of PE, bedside echocardiography was performed to direct management. Indicators of cor pulmonale and right heart strain were apparent including right ventricle dilation, reduced tricuspid systolic excursion, and a deformed left ventricle with "D sign". Most notably, a right atrial thrombus was detected, a finding not initially seen on CTA. Ultimately, prompt detection of the effects on the right ventricle by bedside echocardiography directed the next step in this patient's clinical course without delay.

## 1. Introduction

Quick detection and treatment of pulmonary embolism (PE) is critical for survival [1]. Among those with PE, right heart strain is associated with higher mortality. Right ventricle (RV) strain and right heart thrombus (RHT) commonly co-exist [2]. Presence of RHT may further compromise hemodynamics, clinically manifesting as hypotension, tachycardia, and right ventricular hypokinesis [3]. Such a condition poses a high risk for mortality [4].

## 2. Case

A 59-year-old female with a history of stage IV lung adenocarcinoma presented to the emergency department (ED) with worsening shortness of breath and cough. Vital signs revealed a heart rate of 136 beats per minute, blood pressure of 87/59 mmHg, and respiratory rate of 28 breaths per minute with pulse oximetry of 98% on room air. Accompanying symptoms included nausea, frequent emesis, and constipation. Her physical exam was notable for diminished bilateral breath sounds, rales, and expiratory wheezes and her electrocardiogram revealed atrial flutter with rapid ventricular response. The tachyarrhythmia and desaturation were new findings for this patient.

*Abbreviations:* CTA, Computed Tomorgraphy Angiography; PE, Pulmonary Emboli; ED, Emergency Department; IVC, Inferior Vena Cava; A4CV, Apical 4 Chamber View; TAPSE, Tricuspid annular plane systolic excursion.

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Portable chest x-ray showed increasing bilateral pleural effusions - the right noted to be larger than the left. Computed tomography angiography (CTA) of the chest confirmed a large right pleural effusion with atelectasis of the right lower lobe. Extensive ground glass opacities in the left lower lobe were discovered and bilateral PE. The most prominent PE was at the left main pulmonary artery. The right atrium (RA) and RV were found to be dilated with RV of a size approaching that of the left ventricle (LV). Contrast was also found to reflux into the inferior vena cava (IVC), a finding consistent with severe pulmonary hypertension, further raising suspicions of right heart strain.

During her ED course, the patient became hypoxic, with her pulse oximetry reading 88% on room air, and suffered worsening work of breathing. Her bloodwork revealed hyperglycemia (163 mg/dL), hyponatremia (121 mmol/L), hyperkalemia (6.2 mmol/L) and low creatine (0.94 mg/dL). Lactic acid levels were also elevated (2.1 mmol/L). Her initial course of treatment in the ED included albuterol, insulin, fluids, diltiazem, and metoprolol. The patient was also put on non-invasive positive pressure ventilation to alleviate her worsening work of breathing. Upon admission to the medical intensive care unit (MICU), the patient was started on esmolol and phenylephrine to maintain her hemodynamics.

Bedside echocardiography was performed (Video 1).

Supplementary video related to this article can be found at https://doi.org/10.1016/j.rmcr.2022.101744

Several findings were apparent: 1) dilation of the RV, 2) evidence of RV systolic function, 3) evidence of a “D” sign on LV and 4) presence of a large right atrial thrombus. These findings are detailed below:

Right ventricle size.

The apical four-chamber view (A4CV) was used to measure the basal diameters of the RV and LV at end diastole. Using the caliper function, the internal diameters at the basal one third of the right and left ventricles were measured from one end of the endocardium to the other at the basal 1/3 region of the ventricles. Measurements of the RV and LV were compared, and the ratio of the RV/LV was calculated to be greater than 1, indicating a severely dilated RV.

Right ventricle function: Tricuspid Annular Plane Systolic Excursion (TAPSE).

Using M-mode in the A4CV, the excursion of the tricuspid valve (TV) lateral annulus was measured from peak to trough. When systolic movement of the TV is less than 1.6cm, RV systolic dysfunction is highly likely. The TAPSE score for this patient was 0.8cm, a sign of RV.

“D” Sign of the Left Ventricle.

The deformation of the left ventricle was measured as a function of RV volume overload. Using the parasternal short axis view, the anteroposterior and septolateral diameters of the right ventricle were measured. When the interventricular septum shifts from right to left, the anteroposterior diameter may increase and the septolateral diameter may decrease, resulting in the appearance of the LV in the shape of “D” rather than circular on the short-axis tomographic plane. This was noted in the patient.

Thrombus in right atrium.

A4CV imaging revealed a large right atrial thrombus (Video 2). The prompt discovery of this thrombus guided the next steps in this patient's care, which included prevention of further clot burden into the heart and pulmonary vasculature via IVC filter.

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## 3. Discussion

In this case, the use of bedside echocardiography was instrumental in the prompt discovery of RHT and RV strain in the setting of PE. These intra-cardiac dynamic findings in the setting of hemodynamic and clinical instability rapidly changed management. Obtaining formal echocardiography in these acute settings results in a time-delay. As bedside ultrasound techniques, inclusive of standard echocardiography assessment, circumvents these challenges, its use in detection and management of right heart failure in PE was proven to be timely.

As the RV fails to contract efficiently in the face of sudden increase in afterload due to large PE, increased size and pressure of the right ventricle may manifest [5]. In this case, the ratio of the RV internal dimension end diastole (RVIDd) as compared to that of the

**Figure 1.** Computed tomography angiography (CTA) of the Chest. Red arrows depict multiple filling defects in the right and left main pulmonary artery.

LV internal dimension end diastole (LVIDd), was greater than 1, suggesting a severely dilated right ventricle. Normal RVIDd/LVIDd is less than 0.6 and the RV is observed to be "severely" dilated when the ratio exceeds 1 [6,7]. Frémont and colleagues [8]. Demonstrated that the right/left ventricular end diastolic diameter, when exceeding 0.9 was predictive of mortality in cases of pulmonary embolism. Khemasuwan et al. also observed the same finding [9]. Mortality among those with acute PE was associated with greater RV/LV end-diastolic diameter ratios.

In RV failure, contraction during systole is impaired. TAPSE is a proxy measurement for RV systolic function and measures the longitudinal excursion of the TV during systole [10]. Normal range for TAPSE is 1.6–3.0cm, with systolic dysfunction apparent when the measurement falls below 1.6cm [10]. In this case, TAPSE function was 0.8cm, suggesting limited excursion of the TV during systole and impaired right ventricular contraction. Khemasuwan et al. found an association between TAPSE and hemodynamic instability, need for mechanical ventilation, and long-term survival in those with PE [9].

RV strain can alter the appearance of the LV as the interventricular (IV) septum flattens and deforms towards the LV cavity due to pressure overload. Using the parasternal short axis (PSSA) view at the level of the papillary muscles, the diameter of the greatest anteroposterior length (D1) in the LV was taken as a ratio to the greatest septolateral length (D2) at end diastole and end systole. A flattened appearance of the IV septum combined with a D1/D2 ratio $>1$ suggests RV overload. During massive PE, dilation of the RV may flatten the interventricular septum, and limit LV diastolic filling, thus decreasing preload, and further compromising hemodynamics [11].

In this case, discovery of the RHT was pivotal as those with acute pulmonary embolism combined with right heart thrombus (RHT) have significantly higher cumulative mortality than those without RHT [4]. Those with RHT have a higher risk of recurrent clots, thus decreasing long term health outcomes [12]. Action was quickly taken to optimize the care of this patient, guided by bedside ultrasound techniques. Placement of an IVC filter was attempted by interventional radiology, but then aborted as the patient became hypotensive, hypoxic, and unresponsive during the procedure.

## 4. Conclusion

Ultrasound was critical in detection of a large right atrial thrombus, previously not captured on other chest imaging. In the setting of acute right heart failure in pulmonary embolism, the use of bedside ultrasound and echocardiography is suggested to guide critical management decisions.

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## Declaration of competing interest

None.

## Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.rmcr.2022.101744.

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