



Vascular Interventions Case Report

Potential risk during catheter-directed thrombolytic therapy for pulmonary embolism and how to avoid it

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ABSTRACT

Pulmonary embolism (PE) remains one of the highest causes of cardiovascular mortality worldwide. Systemic thrombolysis for acute PE reduces cardiovascular collapse but has the potential to cause major complications, including intracranial hemorrhage, systemic hemorrhage, immunologic complications, hypotension, and myocardial rupture. Catheter-directed thrombolysis accompanied with high-frequency ultrasound reduces systemic dose, allows increased local dose, and expedites clot lysis at the site of embolism. Although rare, some patients may have a patent foramen ovale or other atrial septal defect (ASD) which cannot be visualized during fluoroscopy which may complicate this procedure. A 41-year-old diabetic smoker presented to the emergency department with hypoxia, tachycardia, and light headedness. Computed tomography angiography (CTA) of the chest revealed bilateral PE with right ventricular enlargement and right heart strain pattern. Transthoracic echocardiogram revealed right ventricular enlargement. He was diagnosed with submassive PE. He underwent right heart catheterization with two angled pigtail catheters manipulated through the right heart to reach the right and left pulmonary arteries, however on frontal fluoroscopy, the catheters appeared slightly more caudal than would be expected. Lateral fluoroscopy was performed which did not show the catheter going through the expected anterior curvilinear course of the right ventricle and pulmonary trunk. Contrast was injected into each pigtail catheter and this demonstrated retrograde flow of contrast back into the left atrium, confirming that the catheters were positioned in the pulmonary veins, having passed through an ASD. On review of CTA chest, there was a visible patent foramen ovale. Congenital heart defects are rare but can complicate certain procedures and interventionalists need to be aware of this possibility. Catheter position more caudal than the pulmonary artery silhouettes should alert the operator to the incorrect placement in the pulmonary veins through an ASD. In these circumstances, lateral fluoroscopy will show absence of the catheters along the expected anterior curvilinear route of the right ventricle, pulmonary infundibulum, and pulmonary trunk. Contrast injection will show centripetal flow back to the left atrium rather than the centrifugal flow away from the heart. Other potential confirmatory methods include pressure monitoring and blood gas sampling. In addition, careful scrutiny of the CT angiogram for an ASD before the procedure may alert the operator to this potential pitfall. The interventionalist must remain vigilant to unexpected anatomical variants to avoid potential harm.

Keywords: Atrial septal, Catheter-directed thrombolysis, Complication, Defect, Pulmonary embolism, Risk

INTRODUCTION

Pulmonary embolism (PE) remains one of the highest causes of cardiovascular mortality worldwide.^[1] Systemic thrombolysis for acute PE reduces cardiovascular collapse but has the potential to cause hemorrhagic strokes at a rate exceeding 2%.^[2] Other major complications

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of systemic thrombolysis include systemic hemorrhage, immunologic complications, hypotension, and myocardial rupture.^[3] Catheter-directed thrombolysis accompanied with high-frequency ultrasound as delivered by the EkoSonic™ Endovascular System (Boston Scientific, Marlborough, Massachusetts, USA) reduces systemic dose which lowers bleeding risks, allows increased local dose, and expedites clot lysis at the site of embolus.^[2,4,5]

Although rare, some patients may have a patent foramen ovale or other atrial septal defect (ASD) which cannot be visualized during fluoroscopy. ASDs account for approximately 10–15% of all congenital heart disease, with an estimated prevalence of about 1–2 cases/1000 live births.^[6] ASDs can be associated with the right ventricular strain and enlargement due to left-to-right shunting.^[7] This may further complicate the classification of PE as the right ventricle may be enlarged from this shunting rather than strain from a PE.

Catheters placed unintentionally through an ASD may erroneously appear to be correctly positioned on anteroposterior (AP) fluoroscopy. In addition, thrombolytic therapy will not reach the target and may, in fact, cause serious consequences.

CASE REPORT

A 41-year-old diabetic smoker presented to the emergency department complaining of light headedness and fatigue. He was hypoxic requiring 2 L of oxygen and mildly tachycardic but not hypotensive. Computed tomography angiography (CTA) of the chest revealed bilateral PE with the right ventricular enlargement and right heart strain pattern. Transthoracic echocardiogram revealed right ventricular enlargement with the left ventricular ejection fraction 40–45%. He was diagnosed with submassive PE. Interventional radiology was consulted for catheter-directed thrombolysis.

After gaining access to the right femoral vein and placement of two 6 French sheaths (Cordis, Miami Lakes, Florida, USA) in the right common femoral vein, two angled pigtail catheters (Cordis, Miami Lakes, Florida, USA) were manipulated up the inferior vena cava and through the right heart to reach what seemed to be the right and left pulmonary arteries, however on AP fluoroscopy, the catheters appeared slightly more caudal than would be expected [Figure 1]. In addition, the interventional radiologist noted that the catheters arrived at their destinations more easily than usual which further raised suspicion.

Lateral fluoroscopy did not show the catheter going through the expected anterior curvilinear course of the right ventricle and pulmonary trunk. Instead, the

catheters were positioned more posteriorly slightly anterior to the spine suggesting that the catheters must have passed through an ASD into the pulmonary veins [Figure 2]. To confirm this suspicion, a small amount of contrast was injected into each pigtail catheter with particular care not to inject any air bubbles and this demonstrated retrograde, or centripetal, flow of contrast back into the left atrium, confirming that the catheters were positioned in the pulmonary veins, having passed through an ASD.

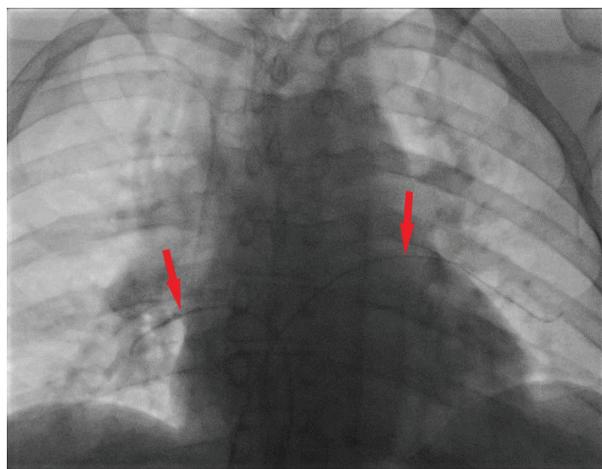


Figure 1: A 41-year-old male presenting with hypoxia and tachycardia diagnosed with pulmonary embolism. Frontal fluoroscopic image showing catheters (red arrows) positioned more caudal than the pulmonary artery silhouettes, passing through an atrial septal defect to the left atrium and to the right and left pulmonary veins.

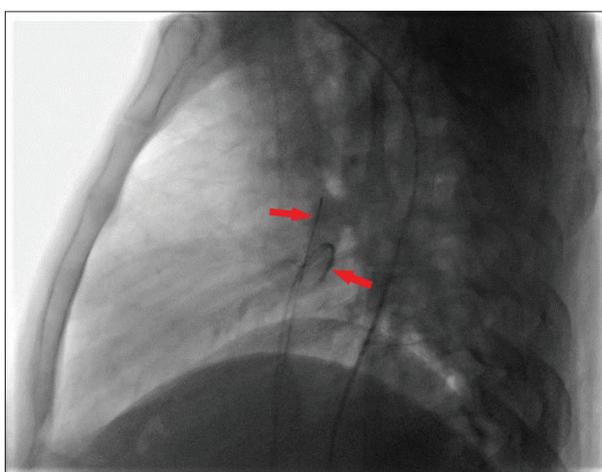


Figure 2: A 41-year-old male presenting with hypoxia and tachycardia diagnosed with pulmonary embolism. Lateral fluoroscopic image showing catheters (red arrows) passing through the atrial septal defect to the left atrium and to the right and left pulmonary veins.

The catheters were retracted into the right atrium and were manipulated from there into the pulmonary arteries. The interventional radiologist was confident that the catheters were now positioned within the pulmonary arteries as the catheters overlay the pulmonary artery silhouettes on frontal fluoroscopy [Figure 3]. Correct position of the catheters within the pulmonary arteries was confirmed by lateral fluoroscopy showing the expected anterior curvilinear course of the catheters as they passed through the right ventricle and pulmonary trunk [Figure 4]. Additional confirmation by contrast injection through the catheters showed contrast flowing centrifugally toward the periphery of the chest as would be expected for pulmonary arterial flow. On review of CTA chest, there was a visible ASD [Figure 5].

DISCUSSION

Catheter-directed thrombolysis with high-frequency ultrasound is a relatively new procedure indicated for submassive PE with the right heart strain or acute PE with hypotension.^[8] Congenital heart defects are rare but can complicate certain procedures and interventionalists need to be aware of this possibility. In this case, we described inadvertent placement of the catheters in the pulmonary veins through an ASD.

Catheter position more caudal than expected and more caudal than the pulmonary artery silhouettes should alert the operator to the incorrect placement in the pulmonary veins through an ASD. In these circumstances, lateral fluoroscopy will show absence of the catheters along the expected anterior curvilinear route of the right

ventricle, pulmonary infundibulum, and pulmonary trunk, confirming incorrect placement. Contrast injection will show centripetal flow back to the left atrium rather than the centrifugal flow away from the heart as would be expected if the catheter was in a pulmonary artery. Other potential confirmatory methods include pressure monitoring and blood gas sampling, however, these may not be immediately available to the interventionalist in the interventional suite. In addition, scrutiny of the CTA chest for an ASD before the procedure may alert the operator to this potential pitfall.

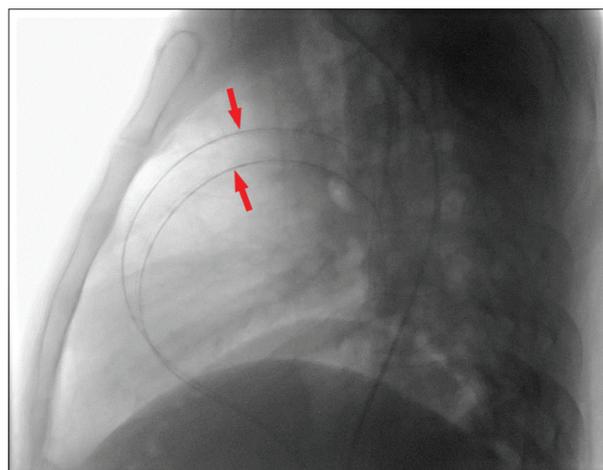


Figure 4: A 41-year-old male presenting with hypoxia and tachycardia diagnosed with pulmonary embolism. Lateral fluoroscopic image showing catheters (red arrows) correctly passing through the right ventricle to the pulmonary arteries.

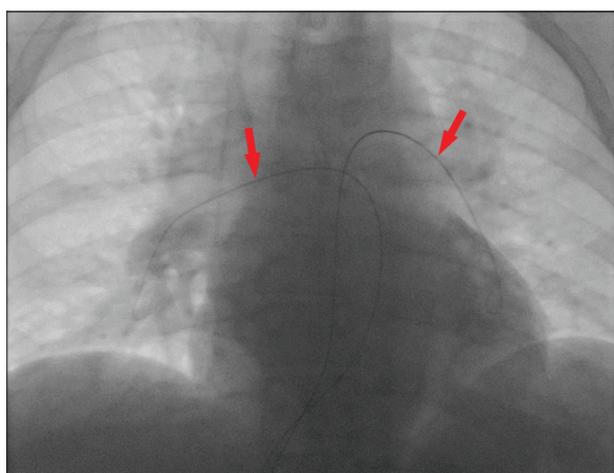


Figure 3: A 41-year-old male presenting with hypoxia and tachycardia diagnosed with pulmonary embolism. Frontal fluoroscopic image showing correct placement of catheters (red arrows) in pulmonary arteries.



Figure 5: A 41-year-old male presenting with hypoxia and tachycardia diagnosed with pulmonary embolism. Computed tomography angiogram of the chest showing an atrial septal defect (red circle).

CONCLUSION

The interventionalist must remain vigilant to unexpected anatomical variants to avoid potential harm. In this case, immediate recognition and confirmation of malposition of the pulmonary arterial catheters within the pulmonary veins through an unrecognized ASD avoided the potentially disastrous consequences of non-treatment of the submassive pulmonary emboli and also avoided potential adverse events as may be caused by inadvertent delivery of air bubbles or thrombolytics to the left heart circulation through mispositioned catheters in the pulmonary veins through an unrecognized ASD.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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