Case 7

Pulmonary CTA in the Setting of Venoarterial Extracorporeal Membrane Oxygenation

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History

A 43-year-old male patient, with a history of chronic thromboembolic pulmonary hypertension with progressive dyspnea and worsening functional status presented for definitive surgical treatment. He underwent thromboendarterectomy which was complicated by acute right ventricular dysfunction requiring venoarterial extracorporeal membrane oxygenation (VA ECMO). Post-operative attempts to wean the patient from VA ECMO were unsuccessful, and echocardiography revealed worsening right heart failure. A pulmonary CT angiography (CTA) was requested to assess for recurrent pulmonary artery thrombosis on post-operative day 11.

Diagnosis

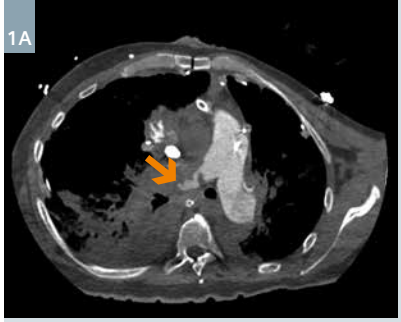
Pulmonary CTA demonstrated new multifocal PE with complete occlusion of the right arterial system (Fig. 1). Perfusion of the left lower lobe pulmonary artery and veins was preserved (Fig. 3). Extensive right-sided pulmonary infarction was present (Fig. 2). The superior vena cava, right atrium, and right ventricle filled with contrast, and contrast refluxed into the hepatic veins and inferior vena cava (Fig. 5A). Attenuation sampled from the main pulmonary artery was greater than 250 Hounsfield unit, allowing the physician to confirm the diagnostic quality of the scan. The arterial limb of the ECMO system and aorta were unopacified, reflecting good bolus timing (Fig. 4).

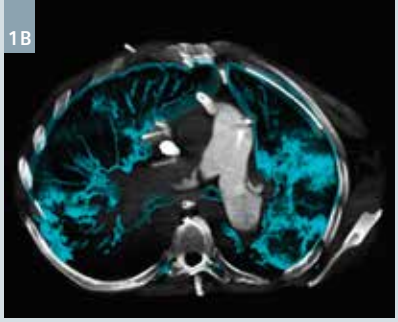
Comments

VA ECMO acts much like a cardiopulmonary bypass. For optimal contrast opacification of the pulmonary arteries via an intravenous injection, VA ECMO needs to be withheld. Prior attempts to wean the patient off VA ECMO had resulted in cardiac arrest. To ensure adequate pulmonary arterial opacification and to maintain systemic perfusion in the setting of diminished cardiac output during the CTA acquisition, 1 mg of epinephrine was administered simultaneously with the discontinuation of VA ECMO in coordination of contrast injection through a peripheral antecubital 18-gauge IV. Pulmonary CTA was performed using a dual source image acquisition at a pitch of 2.5 to reduce acquisition time to limit time off VA ECMO. Following contrast administration and the 1-second image acquisition time, VA ECMO was restarted without incident. The total time within which VA ECMO was withheld, was approximately 12 seconds (scan time to move table during contrast administration and image acquisition). The patient completed the study without complication.

Examination Protocol

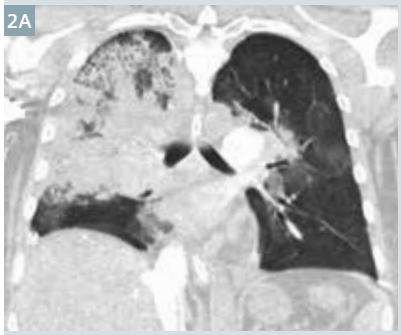
Scanner	SOMATOM Definition Flash
Scan area	Thorax
Scan length	340 mm
Scan direction	Cranio-caudal
Scan time	1 s
Tube voltage	140 kV
Tube current	157 mAs
Dose modulation	CARE Dose4D
$CTDI_{vol}$	13.44 mGy
DLP	457 mGy cm
Effective dose	6.4 mSv
Rotation time	0.28 s
Pitch	2.5
Slice collimation	0.6 mm
Slice width	1 mm
Reconstruction increment	1 mm
Reconstruction kernel	B30f
Contrast	370 mg/mL
Volume	95 mL + 50 mL saline
Flow rate	5 mL/s
Start delay	20 s (time to reach 150 HU within the main pulmonary artery + 9 s)

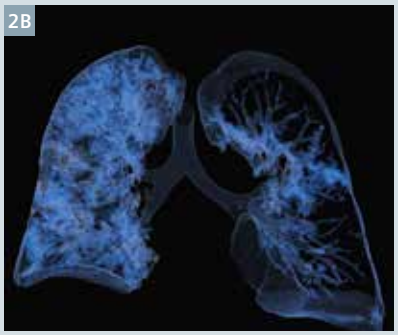




1

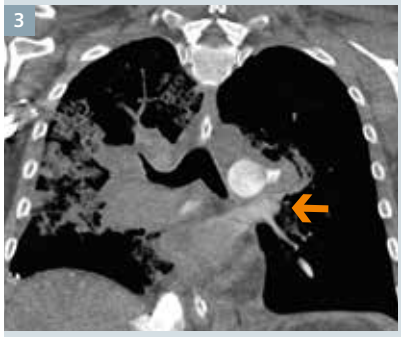
Axial contrast-enhanced (Fig. 1A) and VRT (Fig. 1B) image at the level of the main pulmonary artery: There are irregular filling defects (arrow) in the occluded right main pulmonary artery consistent with thrombosis.

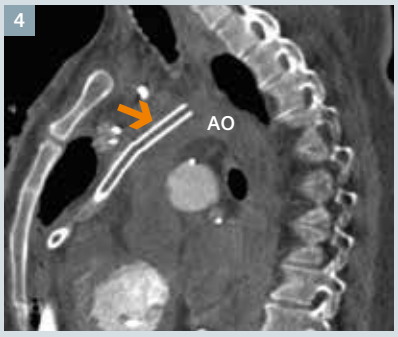




2

Coronal contrast-enhanced MPR (Fig. 2A) and VRT (Fig. 2B) image at the level of the pulmonary hila: Extensive right lung consolidative opacities represent pulmonary infarction.



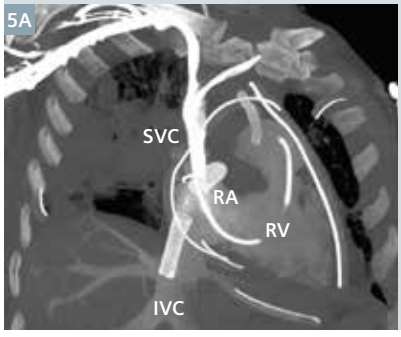


3

Coronal contrast-enhanced image at the level of the pulmonary hila: Perfusion to the left lower lobe is partially preserved; as seen through contrast opacifying the left pulmonary veins (arrow).

4

Contrast-enhanced sagittal oblique image of the aortic arch: The main pulmonary artery is well opacified with contrast and the aorta and arterial ECMO limb (arrow) are unopacified with contrast.



5

Contrast-enhanced coronal oblique MPR (Fig. 5A) and VRT (Fig. 5B) image at the level of the right heart: Contrast injected via a right arm peripheral IV opacifies the superior vena cava (SVC), right atrium (RA), and right ventricle (RV). There is reflux of contrast into the hepatic veins (Fig. 5A) in the setting of elevated right heart pressures. Surgical drains, central venous catheters, and ECMO cannulae are in place.

High-pitch Dual Source CTA technique is commonly used to minimize respiratory and cardiac motion artifacts by way of offering improved temporal resolution. We report a case in which VA ECMO had to be withheld to achieve a diagnostic study, and in which rapid image acquisition was needed to minimize the time off VA ECMO for patient safety. A 1-second scan technique served to limit the duration of systemic hypoperfusion and to decrease the attendant risks to the patient. The diagnostic information gained from this scan directly impacted patient management and ultimately factored into the family's decision to withdraw support. The patient died on post-operative day 12.

Although a lower kV setting would normally be applied for a contrast scan, 140 kV was chosen in this case to reduce the artifacts that might be caused by both arms being in the scan field alongside the patient. As a result, a slightly higher dose (13.4 mGy) than that of a standard routine chest scan was applied. However, it was the appropriate dose considering the patient's size and the critical situation, which left no room for compromised image quality. In keeping with the ACR guidelines,[1] this is still a much lower dose than the dose reference level (DRL) specified for an adult chest CT scan (21 mGy) in the USA. ■

References

[1] CCR–AAPM Practice parameter for diagnostic reference levels and achievable doses in medical x-ray imaging. (http://www.acr.org/~/media/796DE35AA407447DB81CEB5612B4553D.pdf).