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IMAGES IN INTERVENTION

COVID-19–Positive Patient and Hypoxemia

Are Lungs Always to Be Blamed?

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C COVID-19-related respiratory disease is associated with significant morbidity and mortality, especially in elderly patients. In contrast to other forms of pneumonia, patients with COVID-19 pneumonia have preserved lung compliance, but disproportionate hypoxemia and wider right-to-left shunt (RLS) fraction (1). Although hypoxemia is thought to be secondary to respiratory failure, one should also be aware of alternative diagnoses. A 76-year-old woman with a previous history of pulmonary embolism, on life-long anticoagulation, presented to hospital with fever and dyspnea; she was diagnosed with COVID-19. Because her resting oxygen saturation was 82% on room air, and she remained hypoxic on high-flow oxygen, she was intubated. A computed tomography pulmonary angiogram ruled out a new pulmonary embolism; chest x-ray and computed tomography of the thorax demonstrated mild atelectasis in the left lower lobe that resolved over the week. However, she remained hypoxemic, out of keeping with her pulmonary findings. A transthoracic echocardiogram demonstrated a new diagnosis of Ebstein anomaly with moderate tricuspid regurgitation and RLS through a patent foramen ovale (PFO). In view of these findings, she was brought to the cardiac catheterization laboratory. Her mean right atrial pressure was 10 mm Hg; main pulmonary artery pressure was 31/13 mm Hg (mean of 20 mm Hg), with mean left atrial (LA) pressure of 11 mm Hg. While intubated, on a fraction of inspired oxygen of 0.2,

pulmonary venous saturation was 94%, whereas aortic saturation was 82%, suggestive of a significant pulmonary venous-to-aortic stepdown.

Inferior venogram demonstrated streaming of venous flow through the PFO into the LA (Video 1, Figures 1A and 1B), responsible for her hypoxemia. RLS was also confirmed on transesophageal echocardiogram with a bubble test (Video 2). After closure of the PFO with a 30-mm Gore Septal Occluder (W.L. Gore, Flagstaff, Arizona) device (Video 3, Figures 1C and 1D), her oxygen saturation improved to 96% on room air within ~2 min. She was extubated and discharged to follow-up in the adult congenital clinic.

In patients with COVID-19-associated hypoxemia, intracardiac shunting should be considered as an alternative etiology that is likely to worsen with increasing positive pressure ventilation. It is imperative that physicians are cognizant of such a diagnosis, because PFO closure can improve oxygenation (2).

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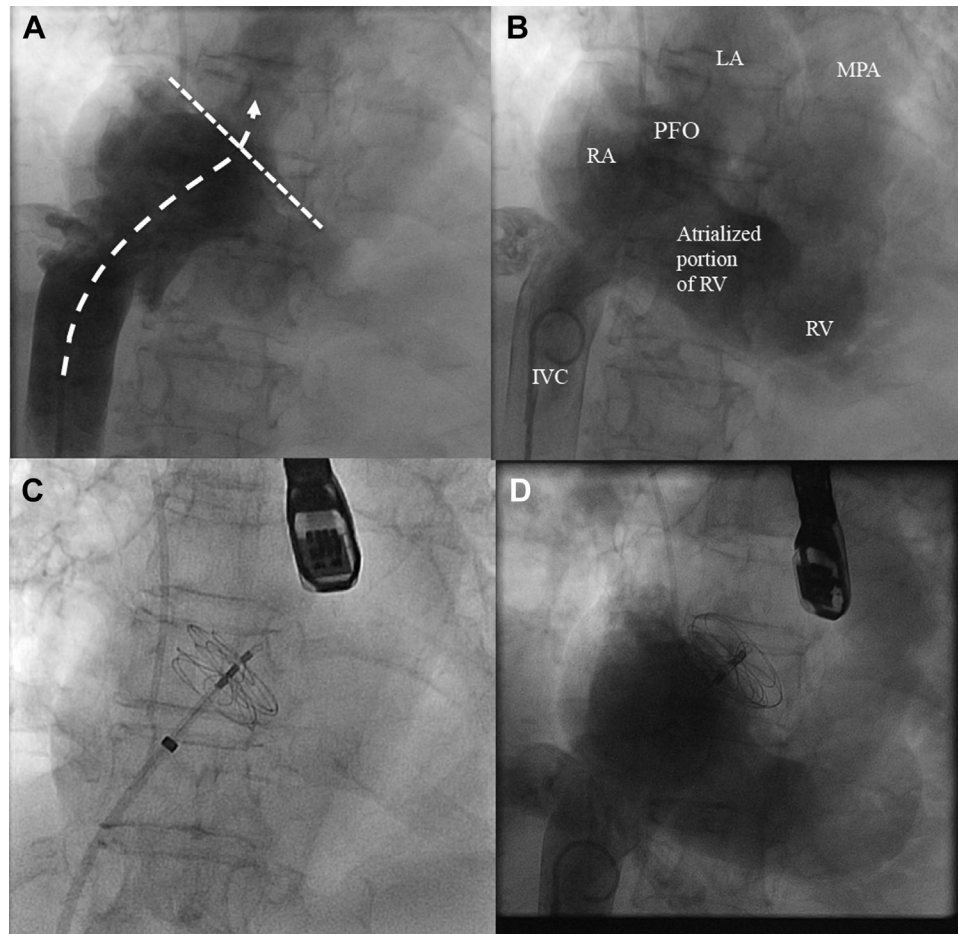
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FIGURE 1 Angiographic Demonstration of RLS Through PFO, Pre- and Post-Closure

(A) IVC gram demonstrating steaming of flow through PFO into the LA; (B) identification of cardiovascular structures; (C) 30-mm Gore Septal Occluder (GSO) device in situ; (D) final angiogram demonstrating the absence of shunting. The **straight dashed line** marks the interatrial septum. The **dashed arrow** indicates IVC flow through a PFO. IVC = inferior vena cava; LA = left atrium; MPA = main pulmonary artery; PFO = patent foramen ovale; RA = right atrium; RLS = right-to-left shunt; RV = right ventricle.

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APPENDIX For supplemental videos, please see the online version of this paper.