Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Journal of Cardiothoracic and Vascular Anesthesia 36 (2022) 2833–2838

Contents lists available at ScienceDirect

Journal of Cardiothoracic and Vascular Anesthesia

journal homepage: www.jcvaonline.com

Diagnostic Dilemma

A Rare Cause of Severe Biventricular Dyssynchrony During Venoarterial Extracorporeal Membrane Oxygenation for COVID-19 Respiratory Failure

Amber Zdanovec, MD*, Dustin Hang, MD*, Adam R. Pagryzinski, MD*, M. Tracy Zundel, MD*, Justin N. Tawil, MD†, Paul S. Pagel, MD, PhD‡,[1]

*Department of Anesthesiology, the Medical College of Wisconsin, Milwaukee, WI
†Department of Anesthesiology, University of Wisconsin School of Medicine and Public Health, Madison, WI
‡Anesthesia Service, Clement J. Zablocki Veterans Affairs Medical Center, Milwaukee, WI

Keywords: Tension pneumothorax; Regional wall motion abnormality; Contractile dyssynchrony; COVID-19; Adult respiratory distress syndrome; Mechanical circulatory support

A 19-YEAR-OLD, 96 KG, 175 cm previously healthy man with COVID-19 pneumonia, sepsis, and adult respiratory distress syndrome was transferred from a community hospital to the authors' institution for treatment with extracorporeal membrane oxygenation (ECMO). The patient had persistent hypoxemia and hypotension despite optimal mechanical ventilation and high-dose vasoactive drug support. He was cannulated for femoral-femoral venoarterial (VA) ECMO shortly after arrival in the intensive care unit. This intervention initially improved the patient's oxygenation and reduced his vasopressor requirements, but hypoxemia and hypotension recurred concomitant with ECMO suction events and reduced flow rates that were only transiently responsive to volume resuscitation and flow adjustment. Transesophageal echocardiography (TEE) was performed, and the following images were obtained (Figs 1-4; Video 1 and 2). What is the diagnosis?

Diagnosis: Severe Biventricular Dyssynchrony Resulting From Left Tension Pneumothorax

A midesophageal 4-chamber TEE view revealed diastolic flattening of the right and left ventricular (RV and LV, respectively) apices associated with dyssynchronous biventricular contraction (Figs 1 and 2; Video 1). A small pericardial effusion was also present. The midesophageal RV inflow-outflow view revealed pronounced RV outflow tract narrowing during diastole (Figs 3 and 4; Video 2). Similar findings were observed in the midesophageal aortic valve long axis view (Figs 5 and 6; Video 3). The transgastric midpapillary short axis view showed severely dyssynchronous LV contraction with apparent tethering of the LV anterior wall (Figs 7 and 8; Video 4). Collectively, the TEE findings strongly suggested that an extracardiac force was acting on the heart, as if cardiac compressions were being performed. The patient continued to experience hypoxemia (arterial oxygen saturations in the mid-80s), hypotension despite escalating infusion rates of vasoactive drugs, and frequent ECMO suction events that only could be managed with reduced flow rates. A chest radiograph was obtained to confirm position of a nasojejunal feeding tube that had been placed when the TEE examination was completed. A left pneumothorax was observed with notable flattening of the

This work was supported entirely by departmental funds.

[1]*Address correspondence to* Paul S. Pagel, MD, PhD, Anesthesia Service, Clement J. Zablocki Veterans Affairs Medical Center, 5000 W. National Avenue, Milwaukee, Wisconsin 53295.

E-mail address: pspagel@mcw.edu (P.S. Pagel).

https://doi.org/10.1053/j.jvca.2022.03.028
1053-0770/Published by Elsevier Inc.

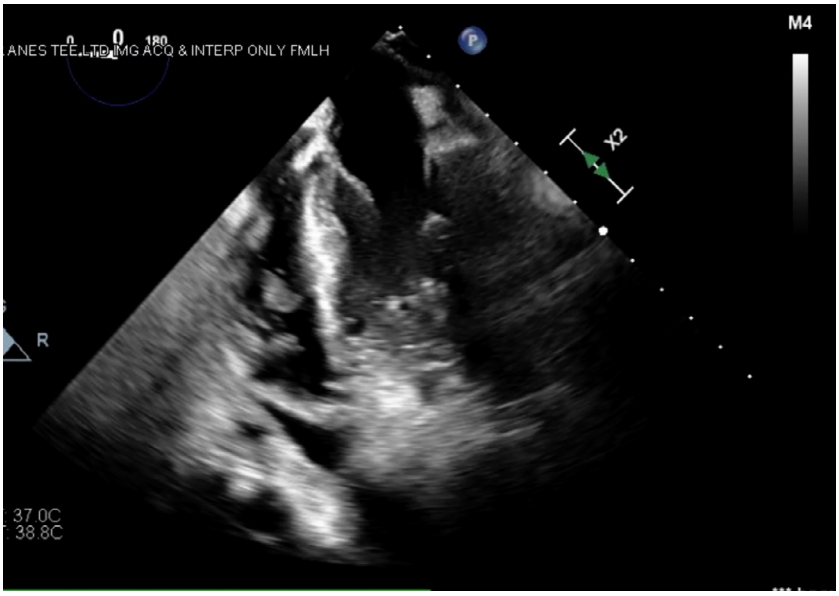

Fig 1. Midesophageal 4-chamber transesophageal echocardiography view during diastole.

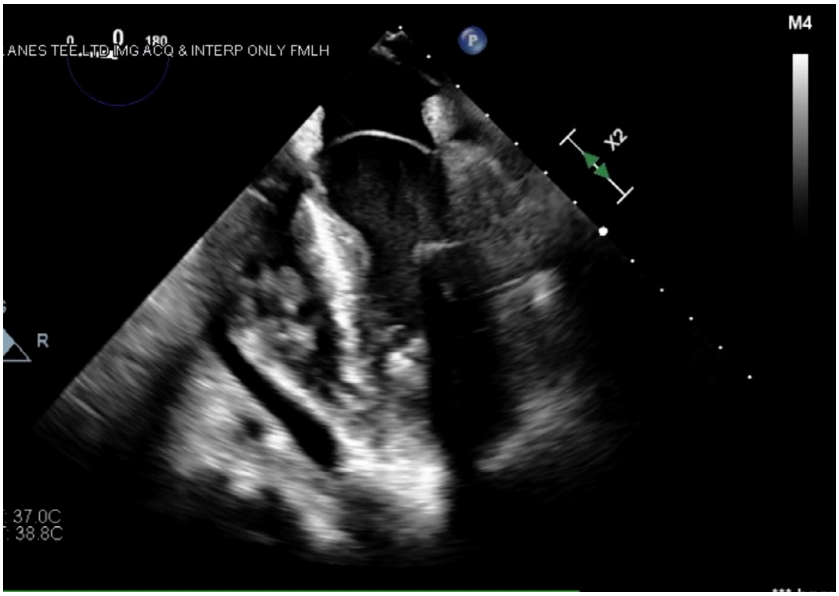

Fig 2. Midesophageal 4-chamber transesophageal echocardiography view during systole.

left heart border by the compressed lung parenchyma (Fig 9). A thoracostomy tube was inserted, which resulted in immediate improvement in the patient's arterial oxygen saturation and hemodynamics, a decrease in vasoactive drug requirements, and the ability to safely increase ECMO flow rates. A repeat TEE examination showed complete resolution of the abnormal cardiac motion.

Pneumothorax occurs in 0.16% to 2% of patients with COVID-19,[1] but its incidence may be much higher (approaching 25%) in those who require mechanical ventilation.[2] Tension pneumothorax during ECMO has been previously described in neonates,[3] but to the authors' knowledge, the current report is the first description of this complication in an adult with COVID-19 treated with VA-ECMO. A triad of paradoxically increased arterial oxygen tension, evidence of reduced peripheral perfusion (as indicated by narrowed pulse pressure and decreases in mixed venous oxygen saturation), and declining flow rates accompanied by hemodynamic instability were the characteristic features of tension pneumothorax in neonates treated with ECMO.[3] These findings were replicated in a study of experimentally-induced tension pneumothorax in dogs receiving VA ECMO.[4] The current patient treated with VA-ECMO displayed 2 of 3 of these previously reported signs of tension pneumothorax: compromised

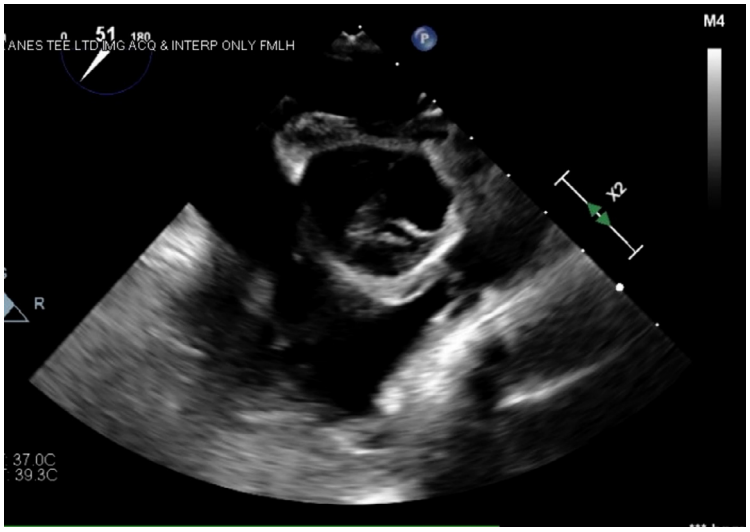

Fig 3. Midesophageal right ventricular inflow-outflow transesophageal echocardiography view during diastole.

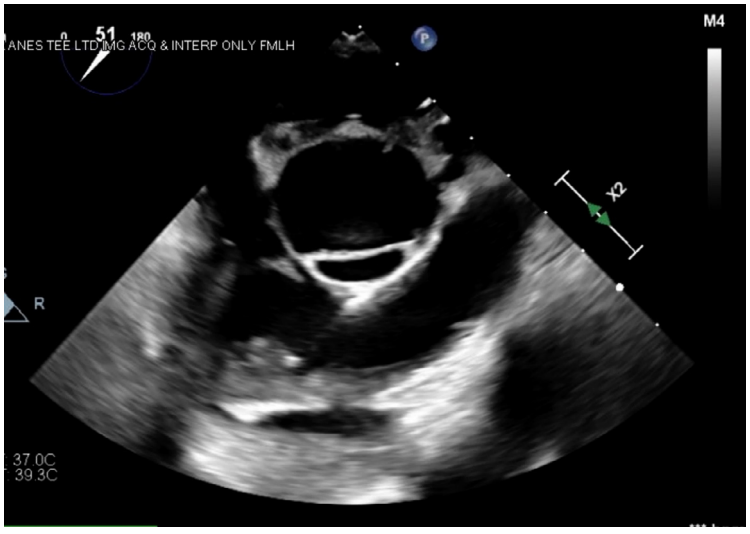

Fig 4. Midesophageal right ventricular inflow-outflow transesophageal echocardiography view during systole.

peripheral perfusion and declining ECMO flows rates associated with suction events and hemodynamic instability requiring high-dose vasoactive drug support. However, the current patient also developed hypoxemia and not an increase in arterial oxygen tension. A difference in ECMO cannulation site and the resulting location of the mixing cloud were probably responsible for this discrepancy. The common carotid artery and internal jugular vein were cannulated in neonates[3] and dogs,[4] whereas femoral-femoral arterial and venous cannulation was used here. Thus, arterial blood gas sampling from a right radial arterial catheter and the decrease in arterial oxygen tension observed in the current patient probably reflected a more distal mixing cloud.

The echocardiographic findings in patients with tension pneumothorax are rarely reported, most likely because of the emergent nature of the pathology. The major TEE findings in the current patient are similar to those that have been previously reported in the literature. Castro et al recently described their TEE findings in 2 ECMO patients with tension pneumothorax in whom dyssynchronous biventricular contraction and flattening of both ventricular apices were observed.[5] Pneumopericardium was suspected initially in the first patient (who was receiving VA-ECMO after a pulmonary thromboembolectomy), but a chest radiograph revealed a large left pneumothorax. The RV of this patient also appeared to be tethered, similar to the current patient's

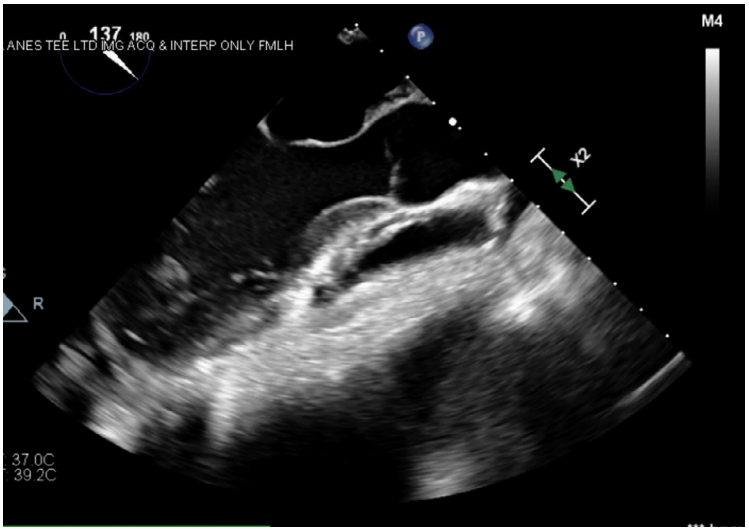

Fig 5. Midesophageal aortic valve long axis transesophageal echocardiography view during diastole.

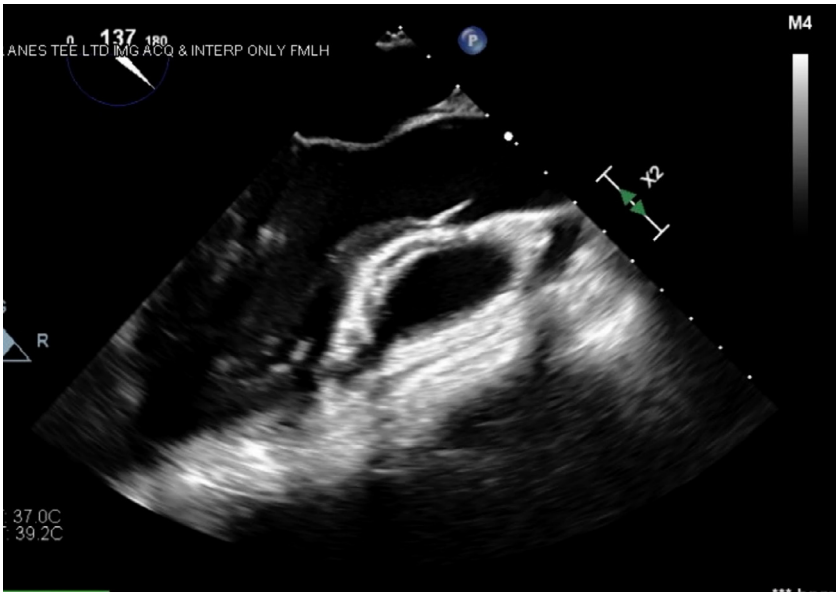

Fig 6. Midesophageal aortic valve long axis transesophageal echocardiography view during systole.

LV in the transgastric midpapillary view (Figs 7 and 8). The other patient in the Castro et al series was undergoing veno-venous ECMO cannulation under TEE guidance when acute changes in cardiac motion consisting of dyssynchronous contraction with diastolic flattening were observed. An iatrogenic pneumothorax after central venous catheter placement was suspected and subsequently confirmed with lung ultrasound imaging. A second case report described a patient undergoing minimally invasive coronary artery surgery who developed hypotension and elevated airway pressures during single-lung ventilation.[6] TEE revealed a mass effect on the right atrium resulting from a right tension pneumothorax. This abnormality resolved after the right pleura was opened.

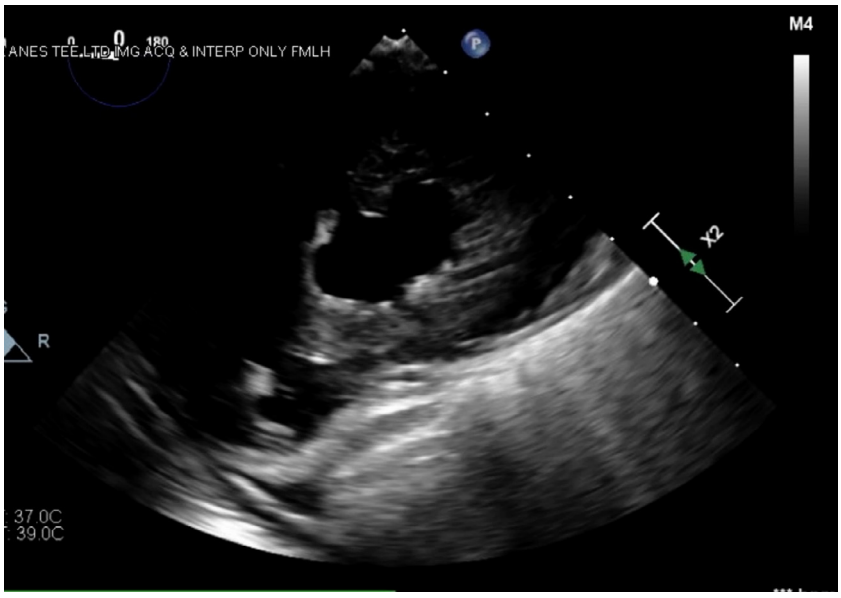

Fig 7. Transgastric midpapillary short axis transesophageal echocardiography view showing left ventricular flattening during diastole.

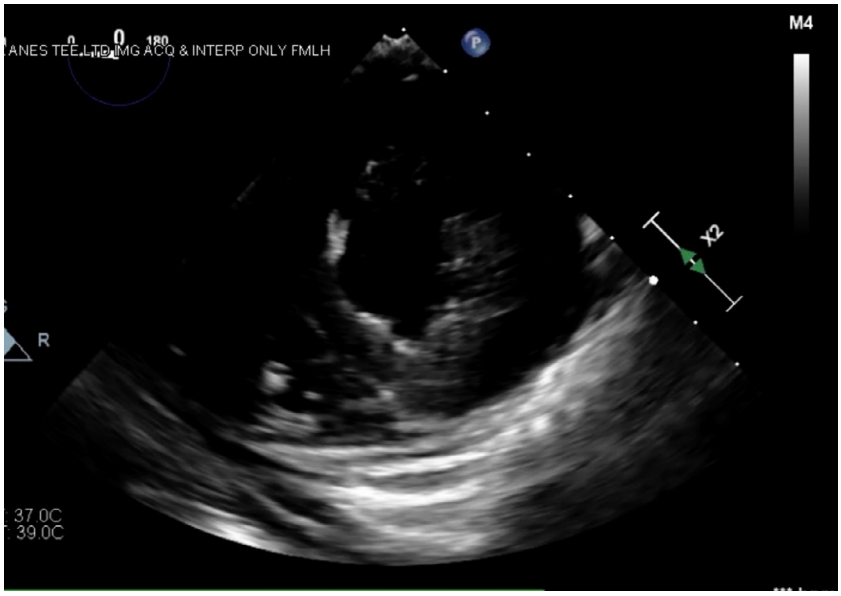

Fig 8. Transgastric midpapillary short axis transesophageal echocardiography view showing apparent tethering of the left ventricular anterior wall during systole.

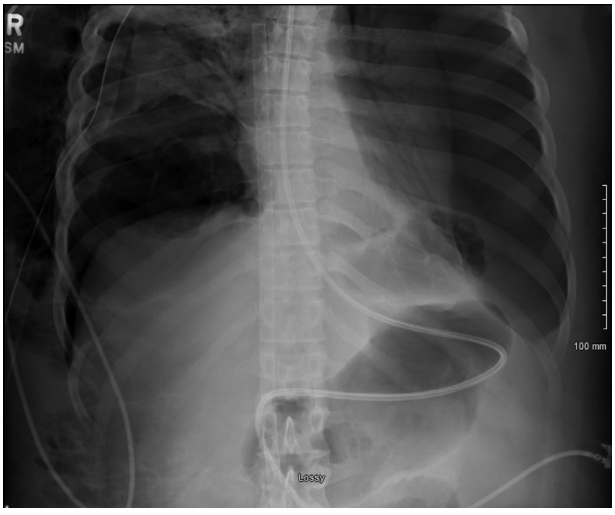

Fig 9. Chest radiograph showing large left pneumothorax.

Conflict of Interest

None.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1053/j.jvca.2022.03.028.

References

1 Marciniak SJ, Farrell J, Rostron A, et al. Covid-19 pneumothorax in the UK: A prospective observational study using the ISARIC WHO clinical characterisation protocol. Eur Respir J 2021;58:2100929.

2 Zantah M, Dominguez Castillo E, Townsend R, Dikengil F, Criner GJ. Pneumothorax in COVID-19 disease - incidence and clinical characteristics. Respir Res 2020;21:236.
3 Zwischenberger JB, Cilley RE, Hirschl RB, et al. Life-threatening intrathoracic complications during treatment with extracorporeal membrane oxygenation. J Pediatr Surg 1988;23:599–604.
4 Zwischenberger JB, Bowers RM, Pickens GJ. Tension pneumothorax during extracorporeal membrane oxygenation. Ann Thorac Surg 1989;47:868–71.
5 Morales Castro D, Lung K, Doufle G. Straight curves: Incidental diagnosis of pneumothorax on transesophageal echocardiography. Am J Respir Crit Care Med 2021;204:e88–91.
6 Agrawal DR, Nambala SP. A lethal tension pneumothorax during minimally invasive coronary artery bypass surgery: Can transesophageal echocardiography pick it up? Ann Card Anaesth 2016;19:747–9.