Associate Editor: J. Kate Deanehan, MD, RDMS

Evaluation of COVID-19–Associated Myocarditis Via Point-of-Care Ultrasound in a Pediatric Patient

Ndah Akwesi Poteh, MD, Amar Chetram Singh, MD, Rebecca Starr Seal, DO, and Paul Adeeb Khalil, MD

Abstract: Coronavirus disease 2019 (COVID-19)–associated myocarditis has been reported from the onset of the pandemic. The presumed etiology is direct damage to the myocardium from severe acute respiratory syndrome coronavirus 2. Common findings include electrocardiogram abnormalities, elevated cardiac markers, and diminished cardiac function. This can lead to heart failure and cardiogenic shock with resultant poor perfusion. Thus, myocarditis has been recognized as a cause of death in patients with COVID-19. Unfortunately, it is difficult to predict the prevalence of myocarditis in these patients given the relative novelty of the pandemic and the lack of available data. Point-of-care ultrasound (POCUS) has been shown to be a useful modality to investigate lung pathology in patients with COVID-19. Bedside cardiac POCUS can also be used to investigate cardiac pathology. This case describes a pediatric patient with COVID-19 who had evidence of myocarditis on POCUS in the pediatric emergency department.

Key Words: myocarditis, COVID-19, POCUS, ultrasound, cardiac

(*Pediatr Emer Care* 2022;38: 94–96)

CASE PRESENTATION

A 14-year-old boy with a history of positive coronavirus disease 2019 (COVID-19) polymerase chain reaction test result 3 weeks prior presented to the emergency department with fatigue, chills, fever, dyspnea, neck pain, and rash. He was previously evaluated at an outside hospital emergency department where he had diffuse ST elevation on electrocardiogram and elevated troponin to 0.17 ng/mL (reference range, 0–0.034 ng/mL) raising concern for myocarditis. Hence, he was transferred to our pediatric emergency department for further investigation. On examination, he was ill-appearing, and had mild tachycardia with a heart rate of 98 beats/min, tachypnea to 21 breaths/min, blood pressure of 117/41 mm Hg, a grade II/VI systolic murmur, and faint crackles at bilateral lung bases. He was afebrile at 97.5°F and maintained normal perfusion with oxygen saturations of 96% on room air. Point-of-care ultrasound (POCUS) was performed at the bedside by a pediatric emergency medicine fellow (postgraduate year 4) and a POCUS fellowship-trained attending physician in order to evaluate cardiac function. Given the abnormal findings on POCUS, a consultative echocardiogram was obtained, which confirmed our findings of decreased systolic function and showed an ejection fraction of 32.8%. It also showed mild dilation and ectasia of the coronary arteries as well as mild left ventricular hypertrophy. The patient was admitted to the intensive care unit where he later became hypotensive and required multiple pressors because of cardiogenic shock, a diagnosis that was aided by the previously obtained POCUS. He was presumptively treated for multisystem inflammatory syndrome in children and received multiple doses of intravenous immunoglobulin as well as high-dose steroids. He was eventually started on antihypertensives, which he continued long-term. Ultimately, his heart function normalized, as did the size of his coronary arteries.

ULTRASOUND FINDINGS

Cardiac images were obtained using a low-frequency phased-array transducer (SP5-1s) on a Mindray (Z.One PRO; Mindray North America, Mahwah, NJ) ultrasound. Upon visual estimation, the left ventricle was dilated and had markedly decreased function. This was observed on both parasternal long-axis and apical 4-chamber views. E-Point to Septal Separation (EPSS) was also noted to be abnormal at 1.4 cm (Fig. 1).

TECHNIQUE

Appropriate personal protective equipment including a gown, gloves and an N95 face mask was donned before performing the ultrasound. The phased-array transducer was used to obtain 4 cardiac windows: parasternal long-axis, parasternal short-axis, apical 4-chamber, and subxiphoid views. The parasternal long-axis view was obtained by placing the transducer over the third intercostal space just to the left of the sternum with the transducer marker facing toward the patient's right shoulder (Fig. 1). The marker was on the right side of the screen. The transducer was kept in the same location for the parasternal short axis view but was rotated 90 degrees such that the marker was now facing toward the patient's left shoulder. The transducer was placed directly below the nipple with the marker to the patient's left for the apical 4-chamber view, and the tail of the transducer was fanned laterally to open up the view of all 4 chambers of the heart (Fig. 2). The transducer was placed just below the xiphoid process and slightly rotated to the right in order to use the liver as an acoustic window to obtain a good subxiphoid view of the heart.

E-Point to Septal Separation was calculated by obtaining the parasternal long-axis view and turning on M-mode. The marker was then placed over the most distal tip of the anterior mitral valve leaflet, which creates an image of peaks and troughs that correspond to the location of the mitral valve leaflet over time (Fig. 3). The taller peak represents the E-point, the point at which the mitral valve leaflet is closest to the ventricular septum, hence leading to early rapid diastolic filling. The shorter peak represents the A-point; the atrial kick that occurs as the left atrium contracts, reextending open the mitral valve leaflet just before ventricular contraction.[1] The distance between the E wave and the septum was measured, which quantitatively assesses how well the mitral valve is opening and therefore helps quantify function. Normal

From the Department of Pediatric Emergency Medicine, University of Louisville, Louisville, KY.

Disclosure: The authors declare no conflict of interest.

Reprints: Ndah Akwesi Poteh, MD, 571 S. Floyd St, Suite 412, Louisville, KY 40202 (e-mail: napote01@louisville.edu).

Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.pec-online.com).

ISSN: 0749-5161

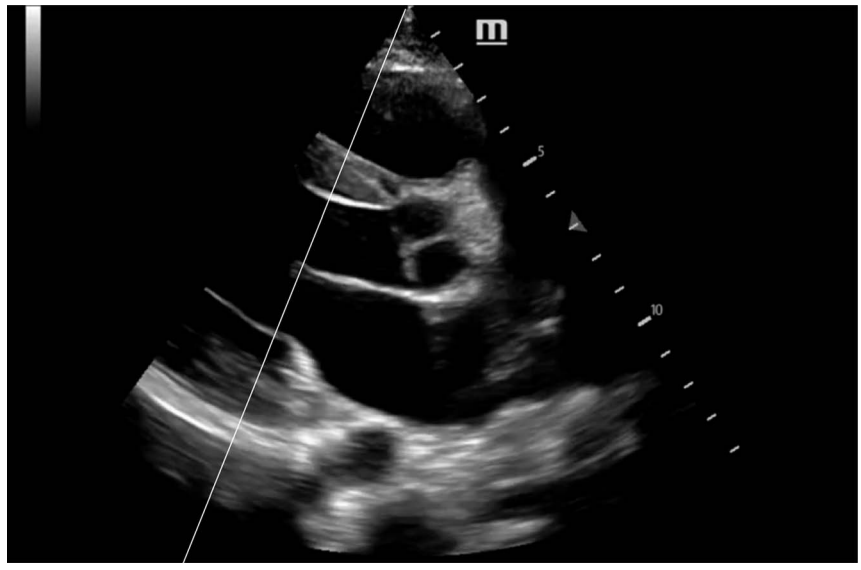

FIGURE 1. Parasternal long axis view. The white line represents where one would ideally place M-mode to obtain the EPSS (supplemental video media attached, Video 2, http://links.lww.com/PEC/A786).

EPSS is <5 mm; values >7 mm generally indicate reduced ejection fraction. Personal protective equipment was then doffed per recommended fashion, and the US machine was thoroughly cleaned with Sani-Cloth germicidal disposable wipes.

REVIEW OF THE LITERATURE

Myocarditis is associated with increased morbidity and mortality in patients who present to the hospital with COVID-19.[2] Symptoms of myocarditis include chest pain, fatigue, palpitations, arrhythmias, and cardiogenic shock. Cardiac POCUS has been shown to have great utility in identifying cardiac abnormalities in up to 50% of adult patients with COVID-19,[3] but to our knowledge, there is no literature reporting its utility in the pediatric population.

Typical findings of myocarditis on initial workup include elevated troponin and aspartate aminotransferase, as well as tachycardia on electrocardiogram.[4] On POCUS, one might notice global left ventricular dysfunction, dilated cardiomyopathy, or reduced ejection fraction.[4] E-Point to Septal Separation is a more

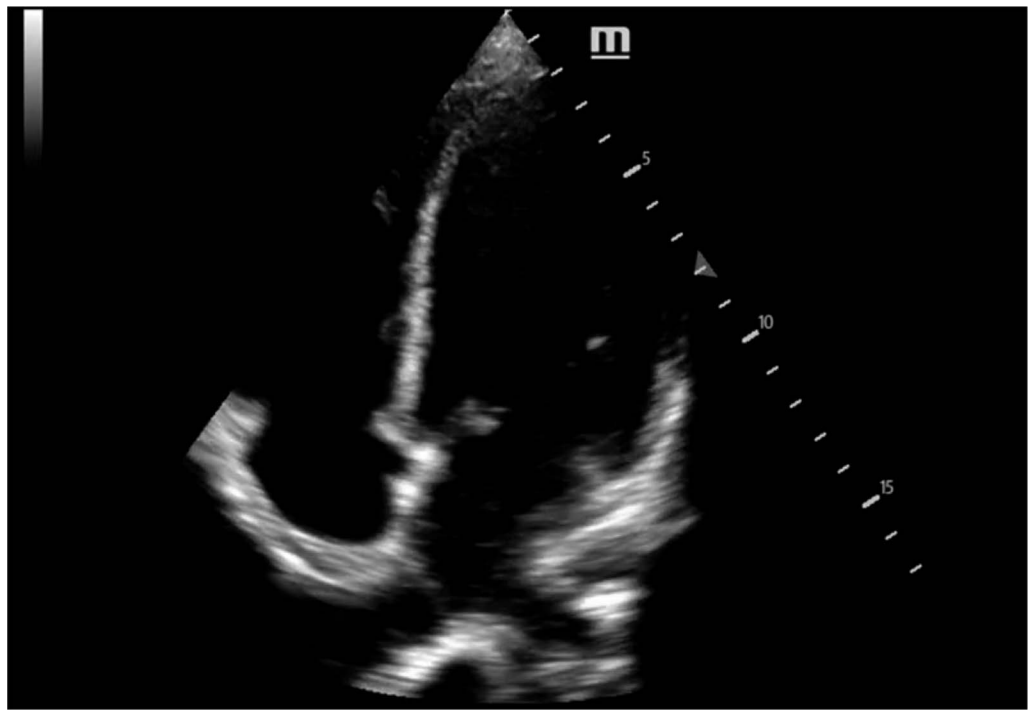

FIGURE 2. Apical 4 chamber view shows a dilated left ventricle. The clip of this still image shows the mitral valve leaflet not slapping the septum wall as it should if normal function (supplemental video media attached, Video 1, http://links.lww.com/PEC/A785).

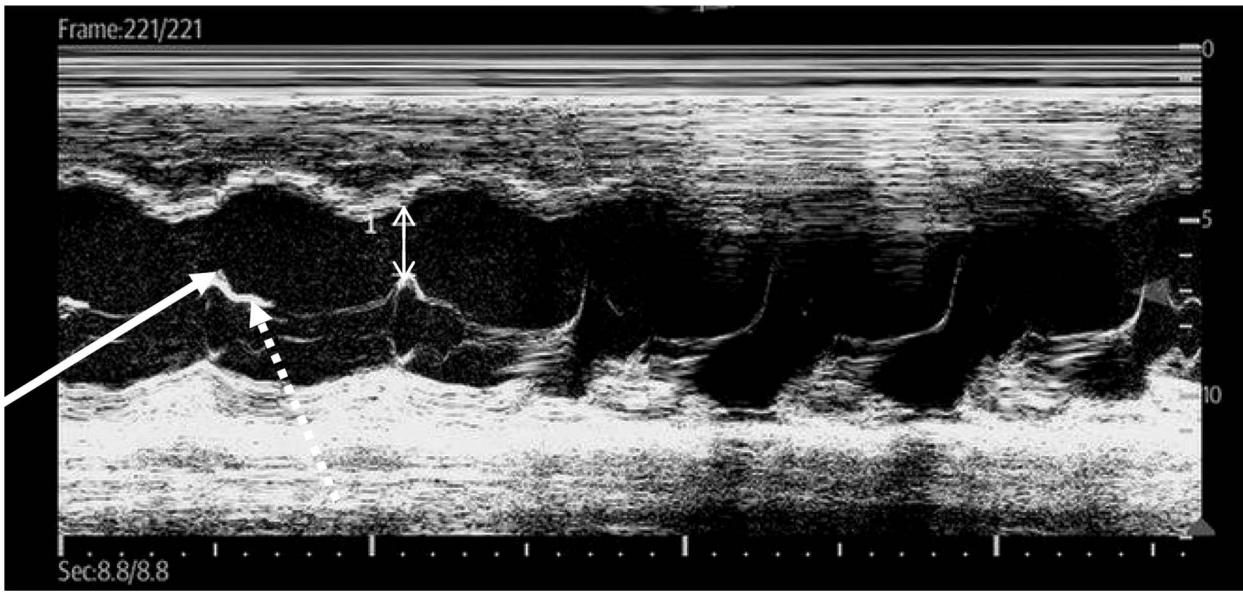

FIGURE 3. M-mode. The double arrow line represents the EPSS. The solid white arrow represents the E wave. The dotted arrow is the A wave.

accurate and objective way of estimating left ventricular contractility and ejection fraction.[1] In a normal healthy heart, the mitral valve leaflet comes in contact with the interventricular septum creating a 0 distance of EPSS. As a strained heart starts failing to pump adequately against increased afterload, the left ventricle dilates, making it difficult for the mitral valve to hit the septum, hence increasing the EPSS and decreasing the ejection fraction. E-Point to Septal Separation >7 mm is generally considered abnormal.[1]

Outside of EPSS, visual estimation of left ventricular ejection fraction has been used by emergency physicians. However, its utility depends on the experience level of the physician.[5] This is usually achieved by evaluating the movement and thickening of the left ventricular wall, the change in size and shape of the left ventricle in all 4 cardiac windows, and the movement of the anterior mitral valve leaflet during the cardiac cycle.[6,7] Left ventricular ejection fraction is considered low if there is an overall decrease in contraction of the left ventricle.

CONCLUSIONS

In our case, a POCUS in the pediatric emergency department was a useful modality for evaluating cardiac function and confirming the diagnosis of myocarditis in a pediatric patient with COVID-19 who later went on to develop cardiogenic shock.

REFERENCES

1. EMDOCS. US Probe: E-Point Septal Separation (EPSS) in the CHF Patient. Available at: http://www.emdocs.net/us-probe-e-point-septal-separation-epss-in-the-chf-patient. Accessed January 30, 2021.
2. Pirzada A, Mokhtar AT, Moeller AD. COVID-19 and myocarditis: what do we know so far? *CJC Open*. 2020;2:278–285.
3. Iyengar-Kapuganti RL, Patel N, Anastasius M, et al. Point-of-care ultrasound findings and clinical outcomes in patients with COVID-19. *J Am Soc Echocardiogr*. 2020;33:1416–1417.
4. Emergency Medicine Cases. Pediatric myocarditis masquerading as respiratory failure. Available at: https://emergencymedicinecases.com/pediatric-respiratory-failure. Accessed January 30, 2021.
5. Gudmundsson P, Rydberg E, Winter R, et al. Visually estimated left ventricular ejection fraction by echocardiography is closely correlated with formal quantitative methods. *Int J Cardiol*. 2005; 101:209–212.
6. Mok KL. Make it SIMPLE: enhanced shock management by focused cardiac ultrasound. *J Intensive Care*. 2016;4:51.
7. Shih T, Lichtenberg R, Jacobs W. Ejection Fraction: subjective visual echocardiographic estimation versus radionuclide angiography. *Echocardiography*. 2003;20:225–230.