

Unexpected Vascular Ultrasound Findings Prompting Hemodynamic Management in an Infant in Respiratory Failure



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INTRODUCTION

With the proliferation of point-of-care ultrasound modalities at the patient bedside, it is often starkly dichotomized into diagnostic versus procedural ultrasound. Although operation of ultrasound is practically equivalent in all modalities, it is important to recognize the crossover that can occur in procedural ultrasound and the potential for making diagnostic discoveries. This case of an infant in respiratory distress helps illustrate this interrelationship.

CASE PRESENTATION

A 6-month-old former 29-week premature male infant was admitted to the pediatric intensive care unit for rapidly progressive respiratory failure after 2 days of fever, diarrhea, and progressive tachypnea and desaturation. At baseline, he had been meeting developmental and growth goals appropriate for adjusted age and was not oxygen dependent at home. His neonatal intensive care unit course was unremarkable, lasting 2 weeks. He did not require intubation in the neonatal period.

The patient presented febrile to a temperature of 100.4°F with a heart rate of 155 beats/min, respiratory rate of 48 breaths/min, blood pressure of 85/55 mm Hg, and oxygen saturation of 82% on room air that increased to 88% with oxygen. On the basis of his desaturation and level of respiratory distress, he was emergently intubated. The ventilator was set to pressure-control ventilation optimized for 8 mL/kg tidal volumes given his age, with a rate of 28 breaths/min, positive end-expiratory pressure of 5 cm H₂O and

fraction of inspired oxygen of 100%. Following an unremarkable intubation, he required durable vascular access. The decision was made to consider subclavian venous access because of the shortness of his neck, making an internal jugular or supraclavicular approach to the brachiocephalic difficult, and diarrhea, making infection of a femoral catheter a risk.

A 13-6 MHz linear-array L25 transducer (M-Turbo; Fujifilm-Sonosite) was placed in a sagittal orientation over the angle of the right clavicle at the junction of the distal and middle third of the right clavicle, visualizing the right subclavian artery and vein in the transverse view (Figure 1, Video 1). At this time, the supervising and trainee physicians performing the guided procedure noted that the artery and vein both appeared pulsatile during systole on the color Doppler, with no apparent diastolic flow in the subclavian vein. On the basis of this finding, cardiac pathology was suspected, prompting cardiac point-of-care ultrasound. The examination was performed by an intensivist using a readily accessible handheld ultrasound device with a phased-array probe, which was maintained in the intensive care unit, mainly for cardiac arrests and interhospital transport (VScan Dual Probe; GE). Apical four-chamber and subcostal long-axis views (Video 2) revealed significant right heart dilation, with the right ventricle appearing larger than the left ventricle. Color Doppler imaging in the apical four-chamber view identified moderate tricuspid valve regurgitation (Video 3). Pulsatile reversal of flow in the hepatic vein was also noted (Figure 2, Video 4). Subcostal short-axis views demonstrated a flattened interventricular septal configuration (Video 5) consistent with elevated right ventricular systolic pressures. Standard echocardiography was then obtained, which confirmed pulmonary hypertension with systemic right-sided pressures. Pulmonary vasodilator therapies were concomitantly initiated. The patient was found to have respiratory syncytial virus infection. In conjunction with other respiratory therapies, the patient recovered and was transitioned from inhaled nitric oxide to sildenafil. He was extubated within 3 days. He was discharged home after 9 days on long-term sildenafil enterally at 0.5 mg/kg three times a day. Discharge echocardiography demonstrated improvement of his increased right ventricular pressures to approximately one half systemic pressures on the basis of septal position.

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DISCUSSION

This case illustrates the applicability of ultrasound as a diagnostic modality even during a procedural application. An unexpected ultrasound finding was noted in the performance of a routine procedure, prompting a rapid cardiac evaluation by trained intensivists, who subsequently requested comprehensive imaging¹ to completely document the suspected diagnosis of pulmonary

VIDEO HIGHLIGHTS

Video 1: Vascular ultrasound, right subclavian transverse plane, without (*left*) and with (*right*) color Doppler of the neck vessels during point-of-care ultrasound-guided access procedure demonstrated the subclavian artery and the out-of-phase pulsatile subclavian vein (*asterisk*). See [Figure 1](#).

Video 2: Subcostal long-axis view demonstrating enlargement of the right atrium and ventricle compared with left-sided structures.

Video 3: Transthoracic modified apical images with color Doppler demonstrate moderate tricuspid regurgitation in an off-axis apical four-chamber (*left*) and right ventricular inflow (*right*) display.

Video 4: Subcostal long-axis image without (*left*) and with (*right*) color Doppler of the hepatic veins demonstrating antegrade diastolic flow and retrograde systolic flow. See [Figure 2](#).

Video 5: Two-dimensional transthoracic echocardiographic subcostal short-axis image at the midpapillary level demonstrates marked systolic flattening of the interventricular septum.

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hypertension as therapies were initiated. The bedside clinicians recognized that this qualitative color Doppler signal was not consistent with typically encountered venous Doppler patterns seen during central line placement, prompting cardiac evaluation. The loss of diastolic flow in systemic veins is a well-described phenomenon during Doppler imaging of tachycardic patients with pulmonary hypertension.²

The practical similarities between procedural and diagnostic imaging reinforce the clear necessity of training individuals who perform ultrasound-guided procedures in diagnostic applications. As the probe is being placed on patients in multiple outpatient and inpatient settings for procedures ranging from vascular access to paracentesis to joint injections, the chance that an unexpected physiologic finding can be detected is always present. In providing the best care possible, clinicians should be ready for this possibility.

Cases such as this also underscore the need for recording and reviewing ultrasound imaging for documentation and future review. This is important for the follow-up of procedural performance, as well as the review of possible complications and, as the situation illustrates in this case, where an unexpected imaging finding can arise. Documentation and image storage, as in this case, should be seen as beneficial for communications among providers and specialties rather than as an encumbrance.

Finally, cases such as these illustrate the fact that fostering practical experience is warranted so that providers can understand normal

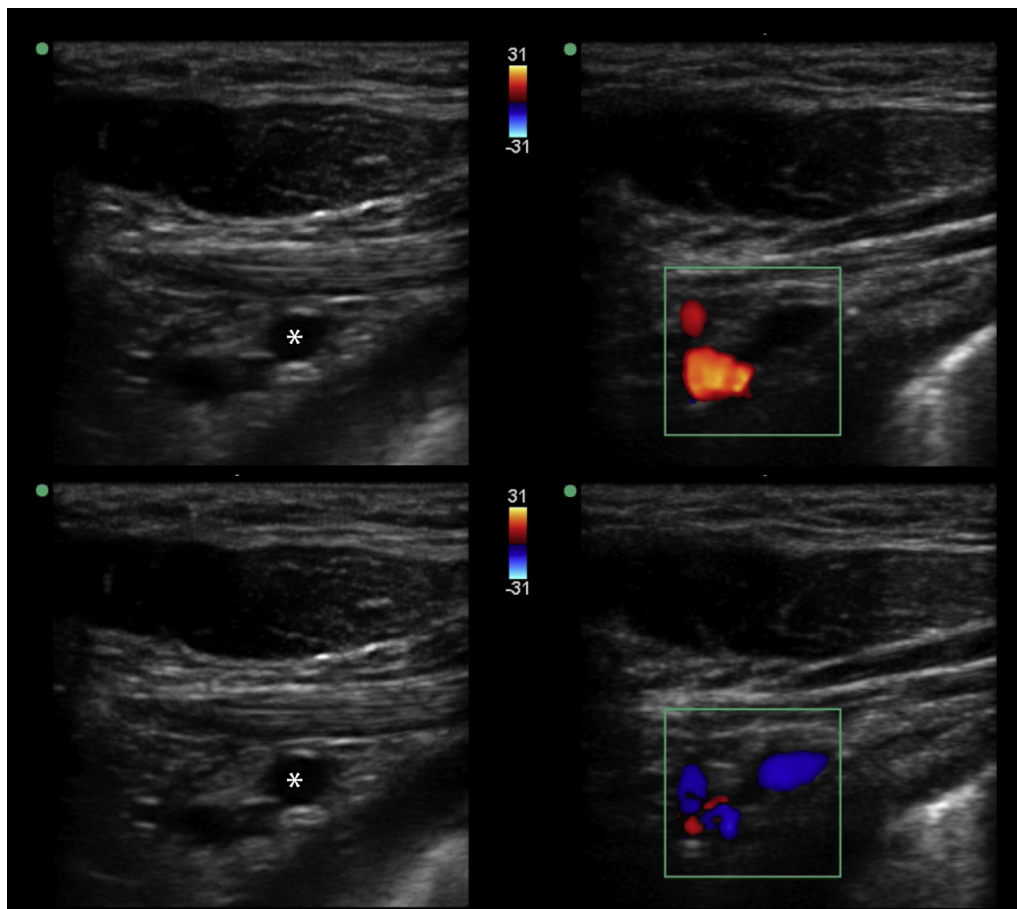


Figure 1 Vascular ultrasound, right subclavian transverse plane, without (*left*) and with (*right*) color Doppler of the neck vessels during point-of-care ultrasound-guided access procedure demonstrated the subclavian artery and vein (*asterisks*) in systole (*top*) and diastole (*bottom*). See [Video 1](#).

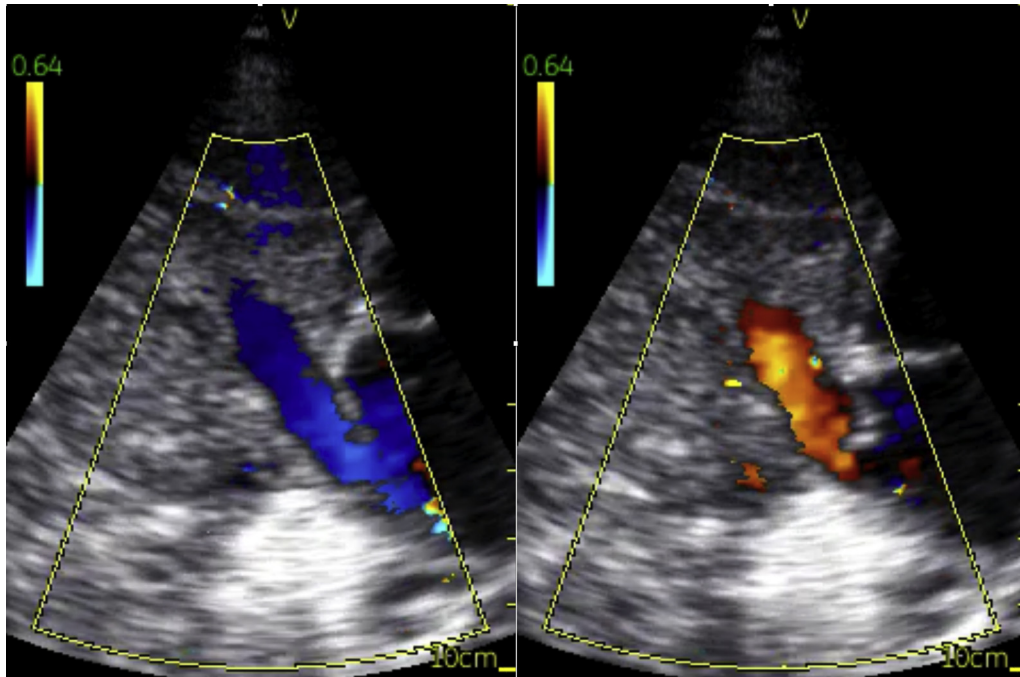


Figure 2 Subcostal long-axis image with color Doppler of the hepatic veins demonstrating antegrade diastolic flow (*left*) and retrograde systolic flow (*right*). See [Video 4](#).

imaging and rapidly discern suspicious findings, as was the case at this clinical institution, where a critical care ultrasound training program was in place at the time. Without avenues for building clinical experience, both normal and abnormal imaging findings are novel to a novice, and their relative significance stays unclear in a learner's mind. Solutions that permit practical experience for learners with expert oversight are necessary and will help combat errors and build point-of-care ultrasound as a durable practice for the future.³

CONCLUSION

Procedural and diagnostic ultrasound applications go together in clinical practice. This case illustrates the importance of recognizing signs of pathology in the performance of procedural pathology. It reinforces that clinicians performing ultrasound should understand its use in totality as opposed to single applications.

SUPPLEMENTARY DATA

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.case.2022.05.006>.

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