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CHEST

Prolonged Respiratory Failure From COVID-19 With New-Onset Shock

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A 68-year-old man with a history of recent COVID-19 ARDS with prolonged respiratory failure requiring a tracheostomy was transferred to the medical ICU because of new-onset shock. The patient's hospital course from COVID-19 was complicated by ventilator-associated pneumonia attributable to *Pseudomonas aeruginosa* and *Klebsiella pneumoniae,* which were successfully treated, and a left femoral vein DVT requiring therapeutic anti-coagulation with enoxaparin.

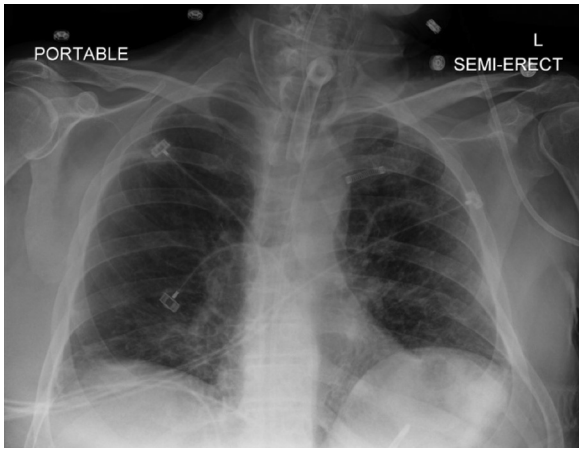

Figure 1 – *Portable CXR illustrating basilar reticular opacities, no consolidation.*

On admission to the ICU, the patient was hypotensive, requiring norepinephrine at 28 μg/min, and phenylephrine at 100 μg/min to maintain a systolic BP of 90 mm Hg. Bedside physical examination was notable for lethargy, and laboratory results were relevant for a lactate of 8 mmol/L and a hemoglobin of 5.6 g/dL, which was a decrease from 9.7 g/dL 24 hours earlier.

A portable chest radiograph illustrated reticular opacities at the bases (shown in Fig 1). A focused bedside ultrasound assessment of the heart, lungs, and abdomen was performed. Relevant findings are illustrated in Videos 1 and 2, which were obtained using a phased array transducer oriented in the coronal plane in the patient's right 4th and 6th intercostal spaces at the midaxillary line. Video 3 is taken at the 6th intercostal space posterior axillary line. All videos were obtained while the patient was in the sitting position at 60 degrees.

Question: What do the ultrasound findings in Video 1 illustrate, and what is the most likely cause of the patient's shock?

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Answer: The series of videos show an extra thoracic fluid collection outside of the chest wall with an anechoic region representing blood and a hyperechoic area consistent with a hematoma suggesting hemorrhage as the etiology of shock

Discussion

Video 1 obtained from the 4th intercostal space at the midaxillary line shows that the lung, diaphragm, chest wall, and liver are all continuous; therefore, the anechoic structure that is present is located outside the thorax and within the soft tissue of the chest. Video 2 is taken from the 6th intercostal space, along the same line as Video 1. Video 2 provides illustration of the key anatomical relationship that exists between the rib spaces and the pleura, as the visualized pleural line on ultrasound is 0.5 cm below the periosteal reflection of the ribs regardless of habitus.[1] Identifying this key relationship confirms that the anechoic collection with fibrous stranding and the hematoma that is visualized is located outside of the thorax. Video 3, taken from the posterior axillary line along the 6th intercostal space, once again confirms that the fluid collection is outside the chest, as the juxtaposition of the liver, lung, and chest wall can be appreciated (Please see Discussion Video for further explanation). Given the new-onset shock, decrease in hemoglobin, therapeutic dosing of anticoagulation, and ultrasound findings of a complex fluid collection outside the chest, hemorrhagic shock from a spontaneous intercostal arterial bleed became the leading diagnosis.

The blood supply of the intercostal spaces within the chest arises from the intercostal arteries, which have anterior and posterior components. The anterior intercostal arteries, if coming from the first six intercostal spaces, are fed by the internal thoracic artery, and below the 6th intercostal space by the musculophrenic artery. The first two posterior intercostal arteries come from the costocervical trunk; from the 3rd rib space downward the posterior intercostal artery arises directly from the aorta.[2] The blood flow within the intercostal arteries is quite robust, with flow reaching up to 70 mL/min on the right and 99.5 mL/min on the left, highlighting how a patient can quickly develop shock if these vessels were to bleed.[3]

The overall incidence of chest wall hematoma caused by intercostal arterial bleeding is unknown, but the few case reports available suggest that it is a rarely encountered condition, with causes being iatrogenesis, chest wall trauma, or spontaneous.[4,5] When examining the chest with ultrasound, a hematoma can have a variety of appearances depending on the age of the lesion. In the acute stage, a hematoma appears as an echogenic structure, progressing to a hypoechoic structure over time, with septations observed in 44% of hematomas after 5 days of being present.[6]

Enoxaparin is a low-molecular-weight heparin (LMWH) that is commonly given for DVT and pulmonary embolus at a dosage of 1 mg/kg twice daily. In patients receiving enoxaparin for DVT or pulmonary embolus, the incidence of major bleeding (defined as being clinically overt and associated with a hemoglobin decrease of 2 g/dL or requiring a transfusion of 2 units of packed RBCs) is 2.9% at 3 months.[7] Monitoring of antithrombotic effects is not usually necessary but can be considered in obese patients and those with renal dysfunction, targeting an anti-Xa level of 0.6 to 1.0 units/mL measured 4 hours after the third dose. In patients receiving LMWH, such as enoxaparin, there is no proven reversal agent. Protamine can neutralize the anti-IIa activity of LMWH; however, the effect of neutralization on anti-Xa is variable. Nonetheless, CHEST recommends that protamine be given at a dosage of 1 mg per 100 anti-Xa units, up to a maximum single dose of 50 mg.[8]

The patient was resuscitated with two units of packed RBCs, and a CT of the chest with IV contrast was performed, which showed a large right posterolateral chest wall hematoma with active arterial extravasation from the 4th and 5th intercostal arteries, confirming the diagnosis of a spontaneous intercostal arterial bleed. Interventional radiology was consulted, and the patient underwent successful embolization, with resolution of his shock state shortly thereafter.

Reverberations

1. *In patients with undifferentiated shock in the ICU, bedside assessment with point-of-care ultrasound can be valuable in narrowing the differential.*
2. *Identification of the periosteal reflection from the ribs aids in visualization of the pleural line, which is located 0.5 cm below the reflection. Recognition of this anatomic relationship on chest ultrasound can help identify whether the abnormality is intrathoracic or extrathoracic.*
3. *Hematomas have a variable sonographic presentation, appearing more echogenic early on and becoming hypoechoic over time.*

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Additional information: To analyze this case with the videos, see the online article.

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