CHEST Postgraduate Education Corner

ULTRASOUND CORNER

Beyond Belief

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A 29-year-old man with type 1 diabetes mellitus presented to our ED complaining of malaise, nausea, abdominal pain, and persistently elevated glucometer readings. This was his third visit to the ED within a week for similar complaints despite reporting full compliance with his outpatient medication. He had not had an episode of diabetic ketoacidosis (DKA) in > 10 years. Review of systems was negative for productive cough, fevers, dyspnea, dysuria, or headache.

Initial vital signs were within normal limits. Physical examination revealed a calm, fatigued-appearing, thin man with normal breath sounds, absence of any rashes, and a nontender, nondistended abdomen. CBC count results were significant only for a mild leukocytosis and the metabolic profile consistent with DKA. Continuous insulin infusion and IV hydration was initiated, followed by admission to the ICU, his third admission within a week. Figure 1 is a portable chest radiograph taken on admission; it was reported as negative for any focal abnormalities.

During rounds the next morning, the ICU team elicited a report of mild, intermittent, pleuritic chest pain over the patient's left upper chest. Examination of his left chest was negative for swelling, erythema, or tenderness. Lung ultrasonography was performed in an attempt to elucidate the cause of his pleuritic chest pain (Videos 1-3).

FIGURE 1. Initial chest radiograph during the third admission for a patient with diabetic ketoacidosis.

Based on these videos and the patient's clinical history and physical examination, what ultrasound finding helps support the diagnosis?

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Answer:

The finding of diffuse B lines is diagnostic of an interstitial syndrome.

An ultrasound survey of several intercostal spaces over the left lung each revealed multiple pleural line artifacts called B lines, diagnostic of an interstitial syndrome. Given the patchy and irregular appearance of the B lines, a presumptive diagnosis of interstitial pneumonia was made, followed by prompt initiation of antibiotics. A CT scan of the chest was ordered for confirmation of findings (Fig 2).

After 2 days of antibiotic treatment, the patient's acidosis and blood glucose control improved without need for insulin infusion. Mild, residual, pleuritic chest pain persisted, and a repeat CT scan was ordered by the ward team 5 days later out of concern for the possibility of pulmonary embolism. Although no pulmonary embolism was found, the scan was remarkable in that all previous ground glass opacities had resolved (Fig 3).

Discussion

This case illustrates the impact of lung ultrasonography in the diagnosis of a radiograph-occult pneumonia. Although a CT scan was used to confirm and define the extent of the findings, the lung ultrasound first detected the abnormalities that led to prompt initiation of antibiotics.

The predominant abnormality on lung ultrasound in this case was the presence of B lines. These artifacts appear distinctly different from the "A line" pattern seen in the normally aerated lung (Video 4).

Hydrostatic fluid, inflammatory exudates, or scarring involving the interlobular septa leads to a width that falls within the resolution of ultrasound, thus changing the artifact pattern in the normal lung. These interlobular septal artifacts are called "B lines" and must have the following five characteristics[1-3]:

- Emanate from the pleural line
- Move with the pleural line
- Appear as discrete, ray-like, vertical lines
- Extend to the edge of the screen
- Erase A lines where they intersect

Although a rib interspace that reveals three or more B lines is abnormal and diagnostic of an interstitial syndrome (B pattern), one to two B lines can be found at the interspaces over normal lungs, caused either by a fissure or lung water secondary to gravity-dependent edema at the bases of the lung (B lines can often be found at the last intercostal space above the diaphragm in normal patients).

The presence of B lines was initially found to be most useful in distinguishing between pulmonary edema and COPD given that a diffuse A-line pattern over the lung surface rules out pulmonary edema as a cause of respiratory failure.[4,5] Although highly sensitive for interstitial syndromes, B lines are nonspecific, given that any disorder that leads to ground glass opacities and interlobular septal thickening on a CT scan will lead to B lines on pleural ultrasound, such as in early or interstitial pneumonias, pulmonary edema, and chronic interstitial lung diseases and fibrosis.[6]

In this case, multiple B lines (three or more) were seen at multiple interspaces, suggestive of an interstitial syndrome (Video 5), and although the finding of such artifacts does not differentiate between hydrostatic and inflammatory causes, the global distribution pattern over the lung and associated findings can be used as follows:

1. Pulmonary edema most commonly appears as a B pattern, whereby the interspaces over the bilateral anterior chest wall reveal multiple B lines along with "sliding lung" and without any appearance of A lines, and often occur with at least small, bilateral, pleural effusions also easily detected by ultrasound. When multiple B lines are present along with A lines, this is called the X pattern, and represents a milder or resolving interstitial syndrome.[7,8]
2. Inflammatory causes such as ARDS or multifocal pneumonias will first present with B lines (sometimes later showing areas of alveolar consolidation on ultrasound). These B lines will usually be found either (1) without lung sliding, due to inflamed and adherent pleural surfaces, (2) unilaterally or in patches over the lung surface, or (3) with a thickened, irregular-appearing pleural line.[1]

The technique for diagnosing interstitial syndrome with ultrasound involves scanning the anterior and lateral portions of the chest, using a minimum of four intercostal spaces per side. On each side, the upper mid-clavicular and inferolateral, anterior axillary areas are first examined, followed by two areas at the level of the diaphragm, one midaxillary and the other in the most posterior area of the diaphragm, with the probe face pointing toward the ceiling when examining a supine patient (thus confirming probe is at the basal, posterior lung surface). An interspace that reveals three or more B lines is diagnostic of interstitial syndrome. Findings at the four points of each hemithorax are then summated to produce a complete "picture" of the lung surfaces.[6,9]

In Figure 2, minimum scanning points are seen in the ultrasound interrogation of a hemithorax. Combining the findings at each interspace leads to a global assessment of extent and patterns of lung abnormalities.