Case Report

Real-time resolution of sonographic B-lines in a patient with pulmonary edema on continuous positive airway pressure

Abstract

Sonographic B-lines of the lungs have been shown to be able to differentiate between congestive heart failure and chronic obstructive pulmonary disease. Studies have shown that B-lines are often present on presentation and resolve during the course of a hospitalization. What is not known is how quickly B-lines resolve in response to treatment. We describe a case of a patient who presented with pulmonary edema and had diffuse B-lines seen on bedside thoracic ultrasound. She was treated with continuous positive airway pressure only, and a few hours later, had no sonographic B-lines. B-lines seen on bedside thoracic ultrasound resolve in real time when pulmonary edema is treated with continuous positive airway pressure. Research to further quantify the use of B-lines in monitoring response to treatment is needed.

An 82-year-old woman presented to the emergency department (ED) with dyspnea for 4 hours. She had a history of atrial fibrillation, congestive heart failure (CHF), end-stage renal disease, hypertension, and coronary artery disease. She was sitting on her couch in her usual state of health watching TV when she suddenly became short of breath. She had a mild nonproductive cough but denied fever, chest pain, or leg pain. She had been compliant with her medications and with hemodialysis sessions. She had been using 2 to 3 pillows to sleep at night for a while. She reported some intermittent leg swelling, which improves after dialysis.

On examination, the patient appeared pale and diaphoretic. Her heart rate was 140 beats/min and irregular; blood pressure, 192/108 mm Hg; respiratory rate, 32 breaths/min; and oxygen saturation, 91% on room air, which improved to 98% on 100% nonrebreather mask. She was in moderate respiratory distress, using accessory muscles to breathe. Chest examination revealed rales, rhonchi, and wheezing bilaterally. She had no jugular venous distention nor any peripheral edema.

A bedside thoracic ultrasound of bilateral anterior and lateral chest walls was performed (Fig. 1). A diagnosis of pulmonary edema was made, and the patient was started on CPAP.

Subsequently, a chest x-ray showed cardiomegaly and pulmonary edema consistent with CHF. An NT-ProBNP level was elevated to 4838 (for the patient’s age, normal <1800). An electrocardiogram showed atrial fibrillation with rapid ventricular response and no ischemic changes.

Three and a half hours after initiation of CPAP, the patient’s respiratory status had improved. A repeat thoracic ultrasound was performed (Fig. 2).

The patient was admitted to the hospital with a diagnosis of pulmonary edema.

Bedside ultrasound of the lungs is a fairly novel tool in the armamentarium of emergency physicians in assessing etiologies of dyspnea. It has been shown to be particularly helpful in differentiating between CHF and chronic obstructive pulmonary disease [1-9]. The thoracic ultrasound relies not on visualization of pulmonary structures but rather on identification of sonographic artifacts called A-lines and B-lines. A-lines (Fig. 3) are hyperechoic, horizontal lines that occur at regular intervals below the pleural line and represent a reverberation artifact between the probe and the pleura. These are found in normal lungs or in pulmonary diseases characterized by hyperaeration such as chronic obstructive pulmonary disease. B-lines (Fig. 3), on the other hand, are hyperechoic vertical lines that originate at and slide with the pleura and extend radially to the edge of the screen without fading. Isolated B-lines may be seen in normal lungs, but diffuse B-lines in multiple zones indicate interstitial thickening, most commonly seen in CHF [8].

Although it has been shown that CHF can be diagnosed on bedside ultrasound when a patient initially presents to the ED, little is known about the dynamics of B-lines. One study
of patients with CHF showed that B-lines resolved over the course of a hospital admission along with symptoms, chest x-ray findings, and BNP [10]. Another study of patients with ESRD shows the resolution of B-lines throughout the course of hemodialysis [11]. This case is unique because it is the first description of real-time resolution of B-lines during ED management of CHF, within hours of initiation of treatment. It demonstrates that in CHF, B-lines reflect acute rather than chronic changes within lung parenchyma. Because chest x-rays can often lag behind clinical findings in CHF, it is possible that ultrasound may be a better imaging modality to follow pulmonary fluid status in patients with CHF and even help determine optimal treatment.

What is also unique about this case is that the patient’s only treatment was CPAP. Continuous positive airway pressure is a commonly used noninvasive method of treating pulmonary edema. Increased airway pressure causes a pressure gradient that forces alveolar and interstitial fluid back into the capillaries, improving gas exchange across the membrane. Ultrasonographically, B-lines disappear as interstitia return to normal thickness, and A-lines appear as the lungs become better aerated and less fluid filled. These findings support the understanding that B-lines are caused by extravascular pulmonary fluid. Furthermore, they suggest that thoracic ultrasound could be used not only to diagnose pulmonary edema but also to monitor response to

**Fig. 1** Eight zones of the thorax are scanned—upper and lower areas of the anterior and lateral chest walls bilaterally. A 2- to 5-MHz curvilinear probe (Sonosite Micromaxx; Sonosite Inc, Bothell, Wash) on abdominal settings was placed on the chest wall perpendicular to the ribs, and the thoracic space was visualized to a depth of 18 cm. These images, performed shortly after arrival to the ED, show diffuse B-lines in all 8 zones. In some zones, the B-lines are so numerous and confluent that they appear as continuous hyperechoic curtains. This diffuse pattern suggests a diagnosis of pulmonary edema.
Fig. 2  The identical zones as in Fig. 1 scanned after approximately 3½ hours of CPAP. No B-lines are present. A-lines can be seen in some zones. These findings represent resolution alveolar and interstitial fluid.

Fig. 3  A-lines and B-lines. On the left, horizontal hyperechoic reverberation artifacts are seen below and parallel to the pleural line. These are known as A-lines and represent normal or hyperaerated lungs. On the right, again, the pleural line is visualized between adjacent ribs. Here, hyperechoic lines known as B-lines originate at the pleural line and extend vertically to the bottom of the screen. Diffuse B-lines suggest pulmonary interstitial thickening, usually secondary to fluid extravasation.
treatment in a real-time fashion. More research is needed in this field.

B-lines seen on ultrasound of the lungs can resolve within a patient’s ED stay. In patients with pulmonary edema, ultrasound could be used to both diagnose and monitor response to treatment.

Andrew S. Liteplo MD, RDMS
Alice F. Murray MBChB1
Heidi H. Kimberly MD
Vicki E. Noble MD, RDMS
Division of Emergency Ultrasound
Department of Emergency Medicine
Massachusetts General Hospital
Boston, MA 02114, USA

E-mail address: aliteplo@partners.org

doi:10.1016/j.ajem.2009.08.013

References


1 Dr Murray is currently at The New Royal Infirmary of Edinburgh, in Edinburgh, Scotland, but was at the Massachusetts General Hospital during the time of the research.