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A Guide to Point of Care Ultrasound Evaluation of Pneumonia

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LEARNING OBJECTIVES

1. Learn the technique for lung point of care ultrasound.
2. Identify and interpret the lung ultrasound findings that would be consistent with pneumonia.

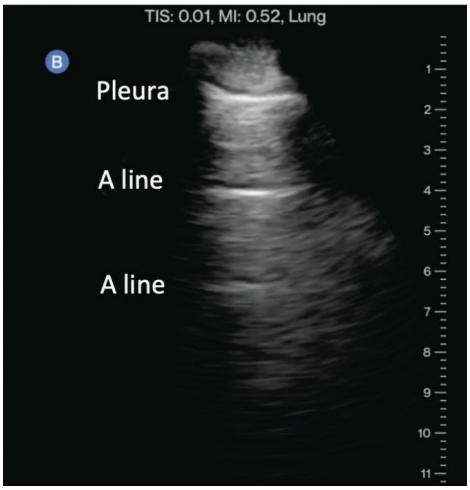
INTRODUCTION

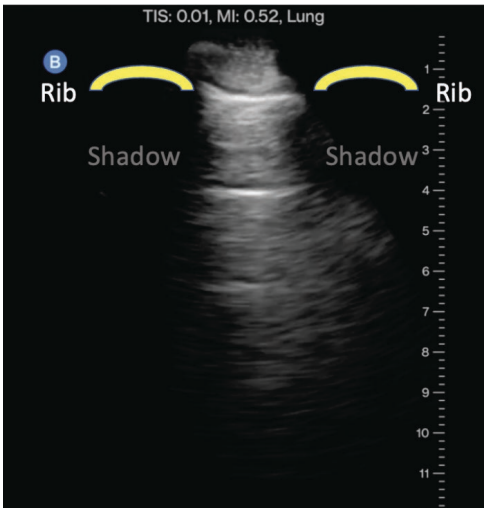
A patient presenting with fever, hypoxia, productive cough, and leukocytosis can be diagnosed with pneumonia without any imaging findings. However, we often rely on X-ray and computed tomography (CT) imaging to support the clinical diagnosis. Ultrasound is an effective imaging modality for identifying pneumonia without delay and radiation risks.[1,2] A meta-analysis by Ye et al. in 2015 found that ultrasound diagnosis of pneumonia had a pooled sensitivity of 0.95 and a pooled specificity of 0.9, which is superior to X-ray imaging which had a pooled sensitivity of 0.77 and a similar pooled specificity of 0.9.[3] This study used CT imaging as a gold standard for comparison.

TECHNIQUE

When performing lung ultrasonography, there should be at least 6 points of imaging: bilateral mid-clavicular 2nd intercostal, bilateral 6th intercostal anterior axillary line, and bilateral PLAPS points or pleural bases. In a study by Danish et al., a 6 point ultrasound lung exam has a sensitivity of 76% and a specificity of 100% in diagnosing an alveolar consolidation.[4] There are different protocols for increasing the sensitivity; our institution recommends assessing in 16 zones if there are no localizing rales or rhonchi on auscultation. If there are localizing sounds, your exam should initially focus on that site.

The probe indicator should be directed caudally at all points. The imaging windows are between rib spaces.

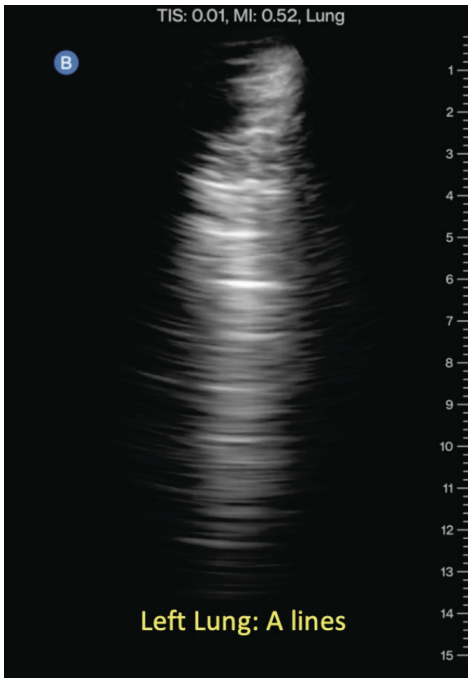


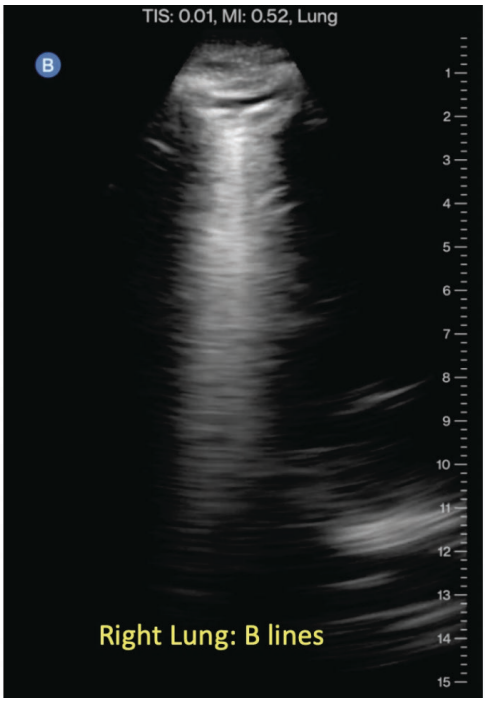


In this healthy lung parenchyma ultrasound image, A-lines are normal imaging artifacts that reflect and repeat the pleura-air interface. The top line is the pleura, where lung sliding would be seen. The black spaces flanking the lung tissue are shadows behind the ribs. Sound cannot pass through the bones and thus cause acoustic shadowing.

Findings Consistent with pneumonia

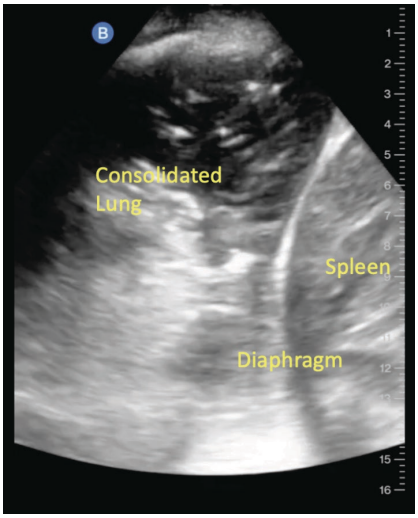
1. Unilateral B lines

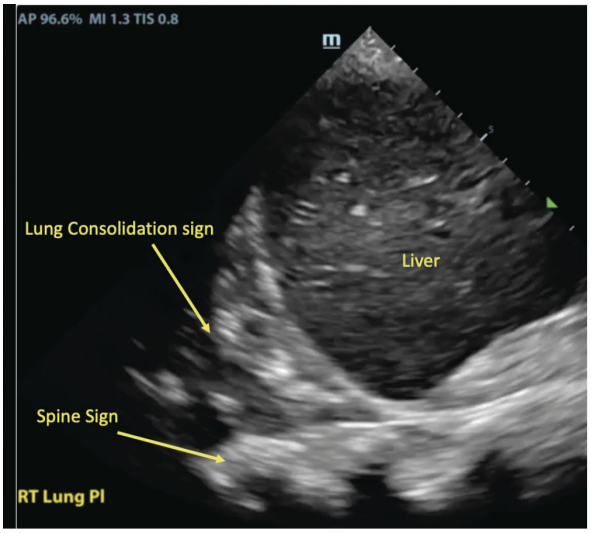




B lines are vertical reverberation artifacts caused by subpleural fluid. "Comet tails" or vertical lines are seen extending from the pleural line. In pulmonary edema, B lines are usually bilateral. Unilateral B lines can suggest pneumonia.

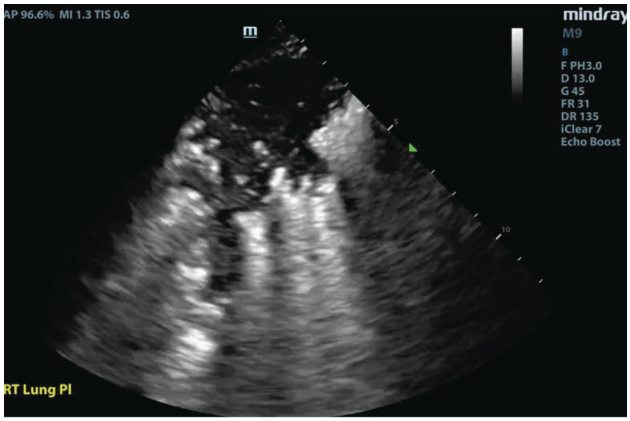
2. Consolidation sign





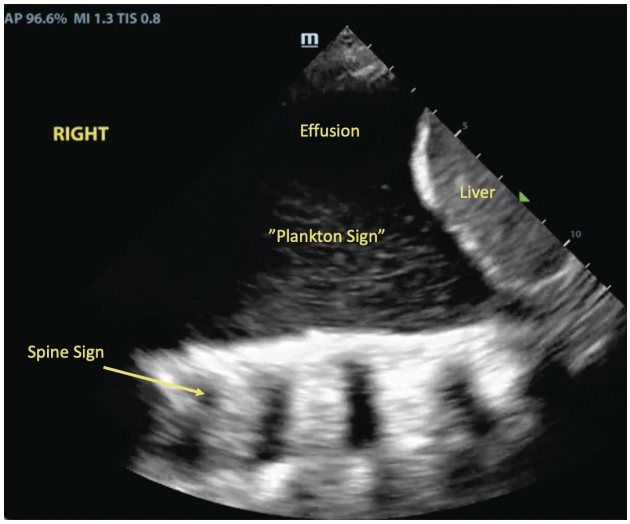
Healthy lung parenchyma will create imaging artifacts such as A-lines because the pleura-air interface disrupts the sound wave transmission. Consolidated lung leads to pus or fluid replacing those previously air-filled alveoli, thus leading to a loss of the A-line artifacts. Instead, the lung tissue looks more similar to solid organs such as the liver or spleen. These images have a lower lobe consolidation, and the consolidated lung looks similar in echogenicity to the adjacent spleen or liver. The diaphragm is used as a landmark to identify the lung bases. The "Spine sign" is another supporting imaging finding. Usually, the thoracic spine vertebral bodies are not able to be visualized because of the air-filled lung scattering the sound waves. However, when the ultrasound waves travel through a dense substance like pneumonia, they can easily reach the spine, resulting in an image.

3. Air bronchograms



The air bronchograms within the "solid" appearing lung would be consistent with air-filled bronchi penetrating areas of alveoli filled with pus and fluid.

4. Plankton sign



In this image, the "static" or "snowy" appearing substance is exudate within a pleural effusion and is termed the "Plankton sign". The Plankton sign can be seen in parapneumonic effusions or empyema. The thoracic vertebral bodies are clearly visualized in this "Spine sign", often used as an indirect finding to support a pleural effusion.

Pitfalls and Pearls

1. B lines are a non-specific finding. B lines are caused by an interstitial lung process, which thus disrupts the A-line artifacts seen in healthy lung tissue. However, this fluid could be due to pulmonary edema, as in heart failure, or due to inflammatory fluid or pus, as in pneumonia.

2. A lack of lung sliding is not specific to pneumothorax. Inflammation related to pneumonia can cause the visceral and parietal lung pleura to become fixed to one another, thus abolishing normal lung sliding.

3. Consolidated lung in the setting of an effusion could represent atelectasis rather than pneumonia. However, air bronchograms within the consolidated area would point toward pneumonia.

4. If you have a unilateral effusion in the setting of a consolidation, ultrasound the effusion thoroughly to identify signs of exudate or septations that may suggest an empyema, which would require sampling and drainage of that fluid. The "Plankton sign" further supports an exudative effusion.

5. An ultrasound diagnosis of pneumonia can be made with focal B lines. A consolidation sign is not necessary.

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