>>EMERGENCY ULTRASOUND

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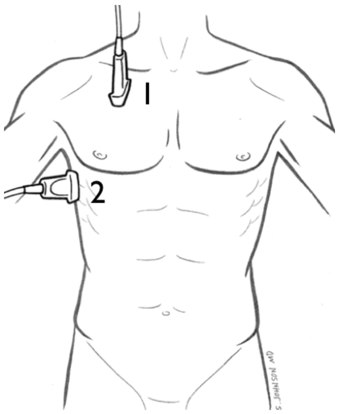
Rapid Ultrasound in SHock: The RUSH Protocol

Figure 1. Ultrasound Diagnosis of Pneumothorax



- Use a 10-MHz probe
- Position 1: anterior chest view
- Position 2: lateral chest view
- Begin in long-axis orientation, then swivel probe to short axis

EVALUATION FOR "COMPROMISE OF THE TANK"

This month, we continue our discussion of the RUSH evaluation of the "tank," looking specifically at step 3, assessment for "compromise of the tank." This step of the protocol uses lung ultrasound techniques to evaluate for compromise of the core vascular circuit. Pulmonary pathology, primarily a tension pneumothorax, may lead to this event. As the following case demonstrates, use of pulmonary ultrasound to detect a pneumothorax can be very helpful in the bedside evaluation of the patient in shock.

CASE

A 72-year-old man calls paramedics due to acute shortness of breath and right-sided chest pain. His history is significant for chronic obstructive pulmonary disease (COPD). Paramedics arrive at his home and find the patient in respiratory distress. On evaluation, the patient has diminished breath sounds bilaterally as well as expiratory wheezing. His blood pressure is 78/50 mm Hg; heart rate, 120 beats/min; and respiratory rate, 35 breaths/min. The paramedics administer bronchodilator medications via nebulized oxygen and IV steroids and transfer the patient to your ED.

When he arrives at the ED, the patient appears to be in extremis with respiratory distress compounded by frank hypotension. You perform your primary survey, then immediately elect to administer BiPAP (bilevel positive airway pressure) ventilation for respiratory support. To assist with the medical evaluation, you bring the ultrasound machine to the bedside and perform the RUSH exam. You note that the patient's heart appears to be contracting well, without pericardial effusion or right ventricular strain. Evaluation of the inferior vena cava and jugular veins demonstrates plethora of these structures, consistent with a high central venous pressure. You decide to proceed directly to lung ultrasound, or step 3 in the second part of the RUSH evaluation.

DISCUSSION

This step in the RUSH protocol is crucial, as a tension pneumothorax can result in hypotension and shock. Tension pneumothorax results from the accumulation of air in the pleural cavity. As the volume of the trapped air increases, the resulting pressure can compress the venae cavae, impairing venous return to the heart and resulting in hypotension. For this exam, the patient is placed in a semi-upright position. A high-frequency linear array transducer is then placed in a long-axis configuration at the second to third intercostal

"Emergency Ultrasound" presents clinical cases involving the diagnostic use of bedside ultrasound in the emergency department. Cases can be explored in more detail on the Web in the SoundBytes section of CMEDownload.com, which can be accessed directly at www.sound-bytes.tv. Instructional videos detailing the components of the RUSH exam are available for download.

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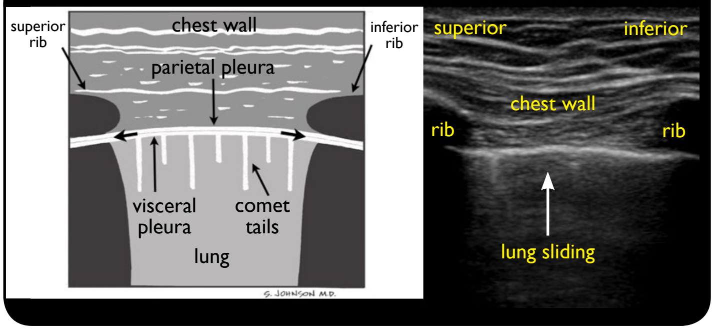
Figure 2. Normal Lung: Long-Axis View



space in the midclavicular line (Figure 1, page 12). A phased-array transducer may also be used with the depth of focus turned down, although the images obtained will not be optimal. If the patient is supine and you are examining him or her from the side, place the probe at the highest level of the anterior chest to best detect a pneumothorax. Identify the ribs both superiorly and inferiorly, then locate the pleural line, which appears as an echogenic horizontal line approximately one-half centimeter deep to the ribs. In the normal lung, the pleural line consists of both the visceral and parietal pleurae closely apposed to one another. As the patient breathes, the visceral pleura can be seen sliding back and forth against the parietal pleura, producing a glistening or shimmering appearance on ultrasound, a finding known as "lung sliding" (Figure 2). Comet tail artifacts, or small vertical echoic lines originating from the pleural line and extending down into the lung tissue, are also seen in the normal lung. To further view the pleural line, the sonographer can swivel the probe on the pleural line to a short-axis orientation with the marker lateral.

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Figure 3. Pneumothorax: Long-Axis View

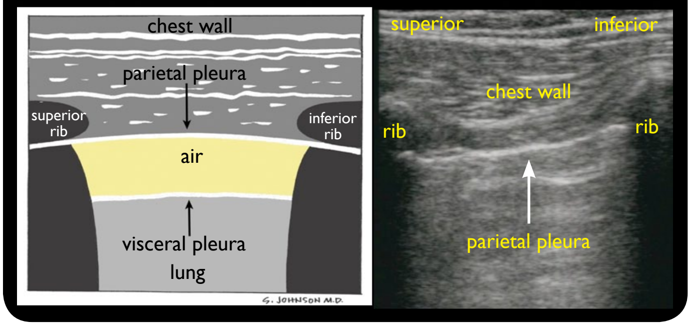
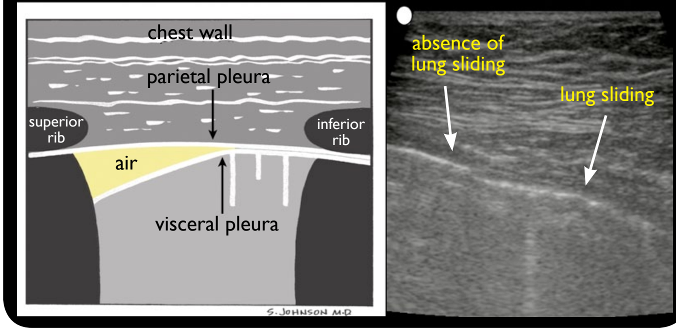


Figure 4. Incomplete Pneumothorax: Lead Point



The presence of lung sliding and vertical comet tails rules out a pneumothorax. When a pneumothorax is present, the air gathered between the parietal and visceral pleurae splits the two layers apart and prevents lung sliding. Instead of demonstrating lung sliding, ultrasound will show a pleural line comprising only the outer parietal layer, which is seen as a single stationary line (Figure 3). In addition, it should be noted that vertical comet tail lines will not be seen. Instead, horizontal lines that originate as reverberation echoes from air may be identified.

The sonographer can also position the probe to look laterally at the midaxillary lines in intercostal space 4 or 5 to further assess for pneumothorax. With a large pneumothorax, lung sliding and vertical comet tails will not be seen either anteriorly or laterally. With a smaller pneumothorax, lung sliding may be noted laterally but not anteriorly, as air will preferentially collect superiorly and anteriorly within the chest cavity. It may be possible to detect the lung lead point, or area where an incomplete pneumothorax touches the chest wall. This point of transition between the area of lung sliding and the absence of sliding may be detected by looking at the pleural line in several intercostal spaces (Figure 4).

CASE ANALYSIS

In the case patient, a pneumothorax was detected in the right chest on bedside ultrasound. Lung sliding and comet tails were identified in the left chest. Needle decompression of the right chest was performed immediately, producing a rush of air and an improvement in vital signs. A chest tube was then placed, and the patient was admitted. It is believed that structural weaknesses in the patient's lungs, resulting from COPD, caused the pneumothorax.

>> Look for further discussion of the RUSH evaluation of the "tank" in an upcoming issue.

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