Sonographic Diagnosis of a Pneumothorax Inapparent on Plain Radiography: Confirmation by Computed Tomography

Andrew W. Kirkpatrick, MD, FRCSC, Alex K. T. Ng, MD, MBChB, FRACS, Scott A. Dulchavsky, MD, PhD, FACS, Ian Lyburn, MB, FRCR, Allison Harris, MB, FRCR, William Torregianni, MB, FRCR, Richard K. Simons, MD, FRCSC, FACS, and Savvas Nicolaou, MD, FRCPC


The focused assessment with sonography for trauma (FAST) consists of imaging the perihepatic, pelvic, perisplenic, and pericardial locations for the presence of free fluid.1,2 Although the pleural spaces may similarly be sonographically evaluated for pleural fluid using sonography,3 the FAST examination has not routinely been used to exclude pneumothorax. Traumatic pneumothorax is a frequent cause of preventable trauma death. Pneumothoraces are usually detected through clinical examination supplemented with plain chest radiographs. Most radiographs initially obtainable in severe blunt trauma settings are anteroposterior (AP) supine films because of concerns regarding spinal injury. In the supine patient, a pneumothorax is usually suggested by the presence of a deep sulcus sign, or the crisp definition of the pericardial silhouette.4 We describe the diagnosis of a small pneumothorax by thoracic ultrasound with computed tomographic (CT) confirmation in a patient after blunt trauma who had a nondiagnostic chest radiograph.

CASE REPORT

A 20-year-old man sustained blunt trauma to the thorax after being ejected over the handlebars of a motocross bike. The patient complained of left pleuritic chest pain and was tachypneic, with the remainder of the vital signs being stable. The breath sounds were equal bilaterally. An emergent supine AP chest radiograph was obtained. This revealed diffuse ground-glass density change to the left hemithorax consistent with a lung contusion. The trauma team leader (an emergency physician), trauma surgeon, and attending radiologist interpreted the chest film. Although suspicious, there was no definitive evidence of pneumothorax (Fig. 1). The mediastinum was also widened without a clear distinct contour of the aortic knob. A portable thoracic ultrasound of both the right and left hemithorax was performed using an XP128 Acusor ultrasound machine (Acuson Corporation, Mountain View, CA) with a 7-MHz linear probe. There was clear evidence of lung sliding and comet-tail artifacts over the anterior right chest, and the posterior aspects of the right and left chest. However, no lung sliding and lack of comet tail artifact was detected over the left anterior chest (figure can be accessed at http://www.vghtraumaresearch.com). FAST examination also revealed a moderate amount of pericardial fluid, but no free intraperitoneal fluid. The patient underwent an emergency CT scan to specifically exclude an aortic arch injury, and to conclusively evaluate the possibility of a partial left pneumothorax. An emergency echocardiogram was also obtained.

The CT scan of the chest confirmed the sonographic suspicion of a partial left anterior pneumothorax (Fig. 2), for which a tube thoracostomy was placed. The CT scan of the chest revealed free mediastinal hemorrhage, prompting aortic
angiography, which excluded a disruption of the aorta. The echocardiogram revealed a right ventricular contusion with mildly decreased ventricular function without evidence of tamponade. The patient was observed in a critical care unit with hemodynamic and electrocardiographic monitoring for 48 hours, after which he made an uneventful recovery.

**DISCUSSION**

Pneumothorax frequently accompanies penetrating chest trauma, and significant blunt chest injuries, and may follow barotrauma. Most pneumothoraces are detected with a combination of clinical symptoms and plain chest radiography. In settings where the clinical findings and plain film chest radiograph are not confirmatory in diagnosing the pneumothorax, CT scan may be used. Sonography has generally not been considered to be of use in diagnosing pneumothoraces. Sonography of the chest is hampered by the high acoustic impedance of air-containing structures. Thoracic trauma with resultant subcutaneous emphysema was actually the most common cause of the FAST examination being indeterminate in one study. However, recent advances in both technology and technique raise the potential to use sonography in emergency diagnosis of thoracic trauma. Recent reports in the literature have documented the ultrasonographic signs associated with pneumothorax including the absence of normal lung sliding and the absence of comet tail artifacts. Lung sliding is identified as a to-and-fro movement with respiration of the hyperechoic line between the chest wall and aerated lung. Comet-tail artifacts are ray-like hyperechoic reverberation artifacts that arise from the visceral pleural line and spread to the edge of the screen, and indicate the absence of a pneumothorax. This technique has been used in Europe in ventilated patients and after performing ultrasound-guided lung biopsies. Although it has not been widely evaluated clinically in North America, a recent mechanically ventilated porcine model demonstrated reproducible changes in the lung sliding patterns after 150 mL of air was injected into the pleural space. These abnormal lung sliding patterns reverted to normal after tube thoracostomy insertion.

Our report demonstrates a successful diagnosis of a small pneumothorax with ultrasound in a patient with blunt trauma, which was not detected by a standard AP supine chest radiograph. Our report is unique in that the sonographic diagnosis was confirmed with CT scan, suggesting that thoracic ultrasound may be more sensitive than routine chest radiography in the detection of small pneumothoraces. Thoracic sonography appears to be a promising technique for the exclusion of pneumothorax when chest radiography is delayed, impossible to obtain, or nondiagnostic.

With new developments in equipment, and more familiarization with the sonographic technique for detecting pneumothoraces, sonography may become a versatile diagnostic modality with which to detect pneumothoraces. There have recently been developed high-quality portable units that can easily be transported by hand. This may facilitate diagnoses in many unusual locations and extreme environments such as the scene of injury, during ground and aeromedical transport, at the front line of conflict zones, aboard ocean-going vessels, and potentially in space. Even in a contemporary terrestrial hospital, sonography could be performed by any operator familiar with the technique and equipment without having to wait for the arrival of even a portable chest x-ray machine and subsequent development of the x-ray film. We suggest that with the appropriate high-frequency transducers available, thoracic scanning for pneumothoraces be considered an additional focus of the FAST examination.

**ACKNOWLEDGMENT**

We thank Mark J. Lee, BSC, Research Associate, Department of Radiology, Vancouver General Hospital and Health Sciences Center, Vancouver, British Columbia, for information technology and multimedia editing and support.

**REFERENCES**


