EDITORIAL

Ultrasound in Pulmonology: the Current Situation

M.A. de Gregorio[a,b] and H. D'Agostino[a]

[a]Full Professor of Radiology, School of Medicine, Health Sciences Center, Louisiana State University, Baton Rouge, LA, USA.
[b]Profesor titular de Radiología, Universidad de Zaragoza, Zaragoza, Spain.

Ultrasound—or echography—has emerged as a powerful tool for those who study diseases of the chest as it has for other specialists. Once a rarely used technique, ultrasound is now indicated for most thoracic diseases. In the past, use was infrequent because of certain inherent limitations of the technique: the bones and the air space of the lung parenchyma create an acoustic barrier that impedes and reflects sound waves, thereby producing major artifacts. In short, given that these two thoracic structures (the bones and the lung parenchyma) represent more than 80% of the content of the chest, the value of ultrasound as a diagnostic tool for the thorax might understandably be questioned.[1]

Moreover, in challenging the place of conventional radiography—the undisputed first choice for diagnostic imaging of the thorax—ultrasound has tough competition from magnetic resonance imaging, and, especially, computed tomography in its many varieties (high-resolution, spiral, multidetector row). Both techniques have shown their value in diagnosing chest diseases: their high resolution and multiplanar viewing capability provide a better approximation of anatomical reality than surgery or even traditional anatomical dissection. Pathological alterations may be observed from any perspective: axial, sagittal coronal, or parasagittal. It is even possible to produce three-dimensional reconstructions from this data, leading to what is today known as virtual bronchoscopy (of the entire tracheobronchial tree) or virtual angioscopy (of the pulmonary and mediastinal blood vessels).[2]

What advantages does ultrasound offer to support its use in diagnosing thoracic diseases? Ultrasound is innocuous, mobile, easy to use, inexpensive, accessible, and can be viewed in real time. These inherent virtues, despite the aforementioned technical drawbacks, provide significant incentives.

The widespread use of real time imaging and small, high frequency transducer probes permit the narrow windows of the intercostal spaces to be used effectively in thoracic evaluation. Moreover, adding ultrasound imaging capability to fiberoptic endoscopes used in the esophagus and bronchi extends and enhances their usefulness for examining peribronchial and mediastinal spaces.[3,4]

Traditional indications for ultrasound, such as the diagnosis of chest wall diseases and pleural effusion, are widely known and used. Without having to move the patient, bedside ultrasound can detect even a few milliliters of fluid in the pleural space. The characteristic echographic pattern of the pleural fluid is anechoic (without echoes) with a posterior band of hyperechoic reflection, while solid lesions are echogenic to a greater or lesser extent.[5] Pleural transudate is generally anechoic whereas pleural exudate, with its greater protein content (>3 g/100 mL), has echogenic septa and may even be homogeneously echogenic.[6] However, certain solid tumors located in the pleura, especially lymphomas and some neurogenic tumors, appear as anechoic masses because they transmit ultrasonic waves, possibly leading to diagnostic error. On the other hand, some pleural exudates and empyema appear as echoic lesions and may even appear hyperechoic at times. This is why the specificity of ultrasound in differentiating solids from liquids is not 100%.[2]

Ultrasound has other indications in the thorax that are less widely known and applied; this does not, however, make them any less valid. Thoracic trauma affecting soft tissues and bony structures, as well as pneumothorax of any origin, can be diagnosed by ultrasound. Several studies have shown that ultrasound can even improve on the results of conventional radiography in fractures of the sternum and ribs.[7,8] Rowan et al,[9] in a recent study of 27 patients suspected of having traumatic pneumothorax, showed that ultrasound was more sensitive than supine chest radiography and as sensitive as computed tomography. Moreover, ultrasound, whether percutaneous or endoscopic, is effective for examining problems of the diaphragm, heart, pericardium, and the large arteries and veins of the thorax.[10-12] Considering these indications, the benefits of ultrasound for emergency

Correspondence: Dr. M.A. Gregorio.
Facultad de Medicina. Universidad de Zaragoza. Zaragoza. España.

Manuscript received June 3, 2003. Accepted for publication June 17, 2003.

assessment of chest injury in the polytraumatized patient are evident, particularly when patient mobility is compromised or computed tomography is unavailable.[13]

Doppler duplex ultrasound, with or without color, has been shown to have a sensitivity and specificity similar to phlebography in diagnosing venous thrombosis of the inferior vena cava and the extremities. Doppler ultrasound is also able to accurately diagnose the presence of a thrombus in cardiac cavities or in the trunk of the pulmonary artery. Currently, the usefulness of this technique in the treatment of venous thromboembolism and, more specifically, pulmonary embolism is unquestioned.[14,15]

Ultrasound was originally presented as an imaging technique to assist in the diagnosis of interstitial lung diseases because it provided information on associated pleural pathology and subpleural lung infiltrates, especially in follow-up studies.[15]

The application of ultrasonic techniques to thoracic interventions has improved and advanced many invasive procedures that were once performed with the guidance of a fluoroscope. Biopsies of lung nodules (peripheral masses in contact with the pleural viscera) as well as drainage of pleural and pericardial effusions, mediastinal and lung abscesses, and pneumothorax can all be performed safely and effectively using ultrasound guidance, with no need for radiation.[16-20] With ultrasound, follow up and monitoring of these interventions can be carried out easily and inexpensively at the patient´s bedside.[21] Ultrasound facilitates correct access to the great central venous pathways, principally the jugular and subclavian veins.

In the future, diagnostic and research applications may move toward using ultrasound in conjunction with endoscopic devices, such as fiberoptic bronchoscopes, esophagogastroscopes, pleuroscopes, and laparoscopes. Encouraging results have already been reported.[3,22] In this sense, technological improvements and new advances will soon permit the use of ultrasound to explore the segmental and subsegmental bronchi, the pleural space, the mediastinum, and any adjacent lesion.

The present relevance and future promise of ultrasound in respiratory medicine is manifest; however, the role of the pulmonologist in ultrasound remains to be determined. At present, thoracic ultrasound is provided by radiology services, where highly satisfactory diagnostic yields have been achieved; nonetheless, caseloads and the increasing range of indications will determine the direction to be taken. Either central imaging services will receive more technical and human resources to respond adequately to demand, or, as has already occurred in other specialties, pulmonologists will have to insist on access to technical resources and prepare themselves to meet this need.

REFERENCES

1. Krejci CS, Trent E, Dubinsky T. Thoracic sonography. Respir Care 2001;46:932-9.
2. McLoud T, Flower C. Imaging the pleura: sonography, CT and MR imaging. AJR 1991;156:1145-53.
3. Okamoto H, Watanabe K, Nagatomo A, Kunikane H, Aono H, Yamagata T, et al. Endobronchial ultrasonography for mediastinal and hilar lymph node metastases of lung cancer. Chest 2002;121:1498-506.
4. Panelli F, Erickson RA, Prasad VM. Evaluation of mediastinal masses by endoscopic ultrasound and endoscopic ultrasound-guided fine needle aspiration. Am J Gastroenterol 2001;96:401-8.
5. Wernaecke K. Sonographic features of pleural disease. AJR Amer J Roentgenol 1997;168:1061-7.
6. Yang PC, Luh K, Chang D, Wu H, Yu C, Kuo S. Value of sonography in determining the nature of pleural effusion: analysis of 320 cases. AJR Amer J Roentgenol 1992;159:29-33.
7. Enguin G, Yekeler E, Guloglu R, Acunas B, Acunas G. US versus conventional radiography in the diagnosis of sternal fractures. Acta Radiol 2000;41:296-9.
8. Griffith J, Rainer T, Ching A, Law K, Cocks R, Metreweli C. Sonography compared with radiography in revealing acute rib fracture. AJR Am J Roentgenol 1999;173:1603-9.
9. Rowan K, Kirkpatrick A, Liu D, Forkhein K, Mayo J, Nicolau S. Traumatic pneumothorax detection with thoracic US: correlation with chest radiography and CT initial experience. Radiology 2002;225:210-4.
10. Goarin J, Cluzel P, Gosgnach M, Lamine K, Coriat P, Riou B. Evaluation of transesophageal echocardiography for diagnosis of traumatic aortic injury. Anesthesiology 2000;93:1373-7.
11. Giron J, Sans N, Fajadet P, Baunin C, Marquenac J. Thoracic ultrasound. Rev Pneumol Clin 2000;56:103-13.
12. Uflacker R, Horm J, Phillips P, Selbey J. Intravascular sonography in the assessment of traumatic injury of thoracic aorta AJR Am J Roentgenol 1999;173:665-70.
13. Mathis G. Thoraxsonography. Part I Chest wall and pleura. Ultrasound Med Biol 1997;23:1131-9.
14. Thomas T, Rosembaum T, Boniface K, Smith J. Deep vein thrombosis in the emergency department. Acad Emerg Med 2003; 10:486.
15. Wells P, Rodger M. Diagnosis of pulmonary embolism: when is imaging needed? Clin Chest Med 2003;24:13-28.
16. Wohlgenannt S, Gehmacher O, Gehmacher U, Kopf A, Mathis G. Sonographic findings in interstitial lung diseases. Ultraschall Med 2001;22:27-31.
17. Ghaye B, Dondelinger R. Imaging guided thoracic interventions. Eur Respir J 2001;17:507-28.
18. Yang P. Ultrasound-guided transthoracic biopsy of the chest. Radiol Clin North Am 2000;38:23-43.
19. Wernecke K. Ultrasound study of the pleura. Eur Radiol 2000;10:1515-23.
20. Klein J. Interventional techniques in the thorax. Clin Chest Med 1999;20:805-26.
21. Vernhet H, Bousquet C, Durand G, Giron J, Marquenac J. Interventional radiology of the thorax. Rev Pneumol Clin 2000;56:115-24.
22. Burgers J, Herth F, Becker H. Endobronchial ultrasound. Lung Cancer 2001;34S:109- 13.