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CHEST SONOGRAPHY

Differentiation of pulmonary consolidation from pleural disease

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Abstract

Ultrasonography was used to evaluate 53 patients with equivocal juxta-diaphragmatic and/or lateral densities in chest radiographs. An air bronchogram, fluid bronchogram, and scattered echogenic foci due to residual air in the consolidated lung parenchyma were used as US criteria of pulmonary parenchymal consolidation. One or more of these signs were observed in 39 patients with a clinical or bacteriologic diagnosis of pneumonia. The US air bronchogram was seen in 32 of the 39 patients (82%), the fluid bronchogram in 37 patients (94%) and the scattered echogenic foci in 30 (77%). In 14 patients, pleural effusion was diagnosed sonographically and verified by aspiration of fluid. The final diagnoses in these cases were pulmonary tuberculosis in 11 patients, staphylococcal empyema in 2, and tuberculous empyema in one patient. It is concluded that US criteria provide a useful differentiation of pulmonary parenchymal consolidation from pleural effusion.

Key words: Thorax, US studies.

The physical limitations imposed by an aerated lung and the bony thorax restrict the potential use of ultrasonography (US) in chest disease. However, US is applied in the evaluation of juxta-diaphragmatic and pleural lesions of the thorax and has been shown to be useful for identifying pleural effusion, empyema, parenchymal consolidation, a solid mass, diaphragmatic rupture, and abscess (2, 3).

The differentiation between pleural effusion, pleural fibrosis, and parenchymal consolidation cannot always be achieved with certainty (4, 5). However, the US air bronchogram (6) and the US fluid bronchogram (1) may be useful for such differentiation.

In this study, high resolution US has been used in equivocal cases. Pulmonary parenchymal consolidation was diagnosed on the following three criteria: 1) the US air bronchogram, 2) the US fluid bronchogram, and 3) scattered echogenic foci due to residual air in consolidated lung parenchyma.

Material and Methods

Fifty-three patients (31 males, 22 females, mean age 26 years, range 4 months – 67 years) were referred for chest US. The indications for referral were clinical signs of chest infection, and a chest radiograph showing juxta-diaphragmatic and/or laterally located densities of an atypical or equivocal nature. In all patients, the chest radiographs included postero-anterior, lateral, and lateral decubitus positions. Ultimate diagnoses were obtained through smear microscopy and culture of sputum, blood or aspirates, or by the clinical course of the disease. The ultrasound examinations were performed with commercially available real-time US units with linear array (4 and 5 MHz) and mechanical sector (3.5 MHz) probes (Toshiba SAL 50, Toshiba 38 AS).

The patients were scanned in supine, prone, lateral decubitus and sitting positions using subcostal, intercostal and, in children, a transcostal approach. The images were recorded with a multiformat camera and video-tape.

Results

One or more of the three US criteria of pulmonary consolidation were met in 39 out of 53 patients. Multiple

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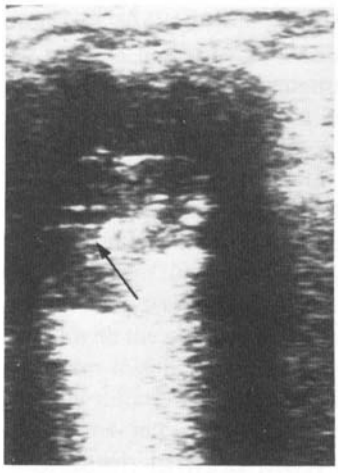

Fig. 1

Fig. 2

Fig. 3

Fig. 1. Transcostal supine scan reveals sonographic fluid bronchogram (→) of consolidated right lower lobe.

Fig. 2. Intercostal supine scan of the left lower lobe shows left lower lobe pneumonia. Linear branching echogenic structures represent a sonographic air bronchogram (→).

Fig. 3. Intercostal supine scan shows scattered echogenic foci due to residual air in the lung parenchyma.

non-pulsatile, anechoic tubular structures consistent with fluid-filled bronchi in a consolidated lung represented US 'fluid bronchogram' (Fig. 1). US 'air bronchograms' were seen as strong echogenic branching lines converging toward the root of the lung (Fig. 2). Scattered echogenic foci that were not found to be linear in different scanning planes suggested residual air in the consolidated lung parenchyma (Fig. 3).

The US air bronchogram was seen in 32 of the 39 patients (82%), the US fluid bronchogram in 37 (94%), and scattered echogenic foci in 30 (77%) (Table).

Eleven out of 39 patients had small concomitant pleural effusions. The definitive diagnosis of pneumonia was based upon the detection of the causative organism by Gram stained smears and culture of sputum or blood in 30 of the 39 patients. In the remaining 9 patients clinical findings alone were highly suggestive of pneumonia. All of the patients responded to treatment with appropriate antibiotics. In a three month follow-up period, the pulmonary consolidations cleared up in chest radiographs in 36 patients while 3 patients were lost to follow-up.

The ultrasound examination in the remaining 14 patients showed only pleural effusions. In 3 of these 14 patients who failed to show gravity-dependent layering on lateral decubitus chest radiography the fluid collection had a moderately echogenic US appearance, in the others it was sonolucent. None of the three criteria for pulmonary consolidation were met in patients with pleural effusion. US guided thoracocentesis in all 14 patients resulted in successful aspiration of fluid. The diagnosis of tuberculosis was made by smear, culture of sputum and pleural fluid, a tuberculous skin test and pleural biopsy in the 11 patients with sonolucent effusion. In the 3 patients with moderately echogenic effusion, the diagnosis obtained at analysis of aspirated fluid was staphylococcic empyema in 2 patients and tuberculous empyema in one patient.

Table

Sonographic findings in 39 patients with pulmonary consolidation

Finding	No. of cases	Per cent
Air and fluid bronchograms	9	23
Air bronchogram and scattered echogenic foci	2	5
Fluid bronchogram and scattered echogenic foci	7	18
Air and fluid bronchograms and scattered echogenic foci	21	54

Discussion

The differential diagnosis between pleural disease and pulmonary parenchymal consolidation that may affect the choice of therapy is not always possible with chest radiography nor with computed tomography under suboptimal conditions (1).

This study has confirmed that chest US may permit such differentiation, not only by detection or exclusion of pleural effusion but also by positive demonstration of parenchymal consolidation.

The US air bronchogram is analogous to the air bronchogram on chest radiographs. The highly reflective interface between the air-filled bronchi and consolidated alve-

oli produce linear branching echoes converging toward the root of the lung.

Like all fluid-filled vascular structures, e.g. in the liver, fluid-filled bronchi in a consolidated lung have the same tubular anechogenic appearance. Pulmonary vascular branches within a consolidated lung could resemble a fluid bronchogram but the distinction is unimportant in a practical sense because the visualization of either normally branching bronchial or vascular structures is proof of a parenchymal consolidating process (1).

Since pneumonia is a dynamic process, areas of consolidation and resolution may be seen at the same time in consolidated lung parenchyma. Air in the alveoli can be identified either in the initial stage or during resolution of the pneumonic process. The scattered echogenic foci are bound to represent air in the consolidated lung.

The US fluid bronchogram (1), and the US air bronchogram (6) in a consolidated lung have been described as separate entities. In the present study, more than one criterion were met at the same time in different regions of the consolidated area. The most frequently met criterion is the US fluid bronchogram, followed by the US air bronchogram and scattered echogenic foci.

The absence of these criteria in 14 patients with equivocal juxta-diaphragmatic and/or laterally located densities in chest radiographs led us to the diagnosis of pleural effusion, and US guided thoracocentesis in these patients resulted in successful aspiration of fluid.

In conclusion, the US criteria of fluid and air bronchograms and scattered echogenic foci are an aid for the sonographer in making a definitive differential diagnosis between pleural disease and pulmonary parenchymal consolidation.

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REFERENCES

1. Dorne H. L.: Differentiation of pulmonary parenchymal consolidation from pleural disease using the sonographic fluid bronchogram. Radiology 158 (1986), 41.
2. Doust B. D., Baum J. K., Maklad N. F. and Doust V. L.: Ultrasonic evaluation of pleural opacities. Radiology 114 (1975), 135.
3. Hirsch S. H., Charter S. J., Chilos P. M. and Colacurcio C.: Ultrasonic evaluation of radiographic opacities of the chest. Amer. J. Roentgenol. 130 (1978), 1153.
4. Laing F. C. and Filly R. A.: Problems in the application of ultrasonography for evaluation of pleural opacities. Radiology 126 (1978), 211.
5. Miller J. H., Reid B. S. and Kemberling C. R.: Water-path ultrasound of chest disease in childhood. Radiology 152 (1984), 401.
6. Weinberg B., Dinkoumakis E. E., Kass E. G., Jeife B. and Zvi Z. V.: The air bronchogram. Sonographic demonstration. Amer. J. Roentgenol. 147 (1986), 593.