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The accuracy of chest sonography in the diagnosis of small pleural effusion

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Background. *The aim of the study was to evaluate the accuracy of chest sonography in the radiological diagnosis of small pleural effusions.*

Patients and methods. *Patients referred for abdominal and/or chest sonographies for various reasons were examined for sonographic features of pleural effusion. From January 1997 till January 2000, 69 patients were included into the study. Fifty-two patients were found to have pleural effusion not exceeding 15 mm in depth, the rest of them served as controls. Subsequently erect posteroanterior and expiratory lateral decubitus projections were done in all patients.*

Results. *Compared to radiological examination chest sonography had a positive predictive value of 92% in the diagnosis of small pleural effusions in our study population. The mean thickness of fluid was 9.2 mm on ultrasonography and 7.6 mm on expiratory lateral decubitus views (P<0.01).*

Conclusions. *Chest sonography showed a high degree of accuracy for demonstrating small pleural effusions and could replace lateral decubitus chest radiographs adequately.*

Key words: pleural effusion-ultrasonography; thoracic radiography

Introduction

A small amount of fluid (5-10 ml) is often present in the pleural space of healthy individuals.[1] Small pleural effusions are not readily identified on conventional radiographic views of the chest.[2] Lateral decubitus radiographs or chest ultrasonography proved to be more efficient methods for demonstrating small amounts of free pleural fluid.[3-6] The data on the smallest amount of pleural fluid detectable vary considerably, but they are essentially within the same broad range whether computed tomography, sonography or X-ray examination are used.[1,3,6-12]

Rigler used lateral decubitus chest radiographs for the detection of small pleural effusions.[13] Other investigators[3,14] have developed the technique and using cadaveric studies[15] have shown that volumes of pleural fluid as little as 5 ml may be detected. Recent reports have proved that minute pleural effusions can be detected using chest ultrasonography.[6,7,17] No formal comparison has been

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made between the thickness of the pleural effusion as seen on sonography with X-ray and the amount of aspirated fluid.

We have compared sonographically detected small pleural effusions with expiratory lateral decubitus radiographs.

Patients and methods

Patients referred for abdominal sonography for a variety of clinical conditions were also examined for unsuspected pleural effusion. Small control group was made up of 17 patients, examined only for clinically suspected pleural effusion, which was not sonographically confirmed.

Between January 1997 and January 2000, 69 patients (51 males, 18 females, 28-80 years old, with the mean age of 57.1 years) were included into the study. Their condition was clinically diagnosed as lung cancer in 30, cardiac failure in 13, metastasis to the lung in 11, pneumonia and pulmonary tuberculosis in 6 and liver cirrhosis in 3 cases.

Following abdominal sonography, the patient was positioned in the lateral decubitus position for 5 minutes; sonography of the lower pleural space was performed with the patient leaning on the elbow.[17] During the examination maximal fluid thickness was measured, with the position of the probe perpendicular to the thoracic wall.[18]

A Toshiba SSA-340A ultrasound unit was used with a 3.7 or 6 MHz convex transducer.

Radiological examination followed if sonography showed a small pleural effusion. A 140 kV Siemens unit was used, with a 2 m film-focus distance for the erect views of the chest, and 1.5 m film-focus distance for lateral decubitus views. For these, the patient was put into lateral decubitus position with 10^0 hip elevations, for 5 minutes prior to exposure. Exposures were taken in expiration, with the central beam aimed at the lateral chest wall and the patient slightly rotated onto the back. The films were evaluated independently by two experienced radiologists with no knowledge of the sonographic findings.

On sonography, the criteria for determining the presence of pleural fluid were: a non/hypo - echogenic zone between the parietal and the visceral pleura and/or changing between expiration and inspiration as well as changing with different positions of the patient or fluttering of the pulmonary edge during respiration.[6,9,19,20]

On x - ray, the criteria were as follows: minimum 3 mm thick density with horizontal level on lateral decubitus view and costophrenic angle density with meniscus sign on erect views.[3,21]

Matching pair's *t*-test was used for analysis of differences between measurements of the fluid layer thickness on chest sonography and expiratory lateral decubitus projections.

The study was approved by relevant ethic committee.

Results

On erect posteroanterior chest radiographs pleural fluid was demonstrated in only 17 of 52 (33%) patients.

Lateral decubitus views were positive in 48 of 52 patients (ie, a positive predictive value of 92%) with sonographically visible fluid. In two cases pleural effusions detected sonographically were confirmed by thoracocentesis. In one patient sonographically positive result was not confirmed either way. In the last case radiography revealed diagnostic error occurred on sonography (Figure 1). The range of fluid thickness was 3-6 mm in these three patients.

In a small control group of 17 patients pleural fluid was not confirmed sonographically nor radiographically.

The mean thickness of fluid was 9.2 mm (SD= +/- 3.3 mm) on sonography and 7.6 mm

(SD= +/- 4.0 mm) on expiratory lateral decubitus views (P<0.01). The ranges of fluid thickness on gray-scale sonography and lateral decubitus radiography were 3-15 mm and 3-11 mm, respectively (Figures 1a, 1b).

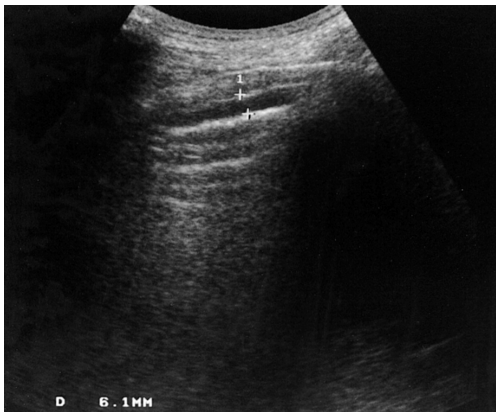

Figure 1a. A 6-mm-thick hypoechogenic zone (calipers) between the parietal and the visceral pleura suggestive of a small pleural effusion.

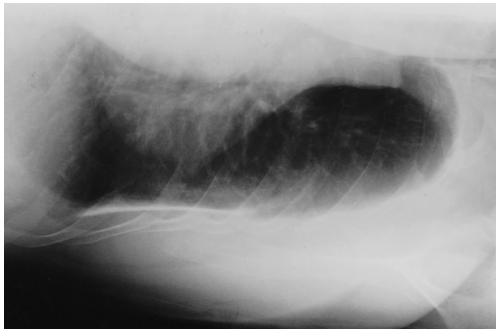

Figure 1b. Left lateral decubitus radiograph clearly shows a flat pleural thickness with calcified plaque on the visceral pleura.

Discussion

In the literature we could not find any exact definition of small pleural effusions. So, our term of small pleural effusions includes clinically silent effusions, which are usually unexpected finding on x-ray or sonographic examinations undertaken for other reasons.

Rigler[13] was the first to use lateral decubitus views for pleural fluid demonstration. He did not use exposure in expiration, however, nor did he expose with central beam aimed at the lateral chest wall, parallel to the expected fluid level. The latter technical improvement was introduced by Hessen[3] together with the elevation of the patient's hip, while obtaining radiograph during expiration was tested in the work of Kocijančič et al.[17] The amounts of pleural fluid detectable this way have been assessed in cadaveric experiments[15] and has been shown to be as little as 5 ml in experimental conditions. This is probably less reliable in practice, because the fluid may not always be completely aspirated with thoracocentesis.

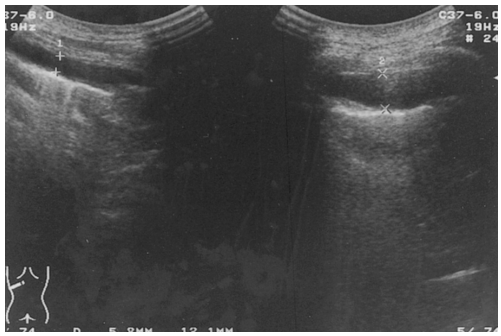

Figure 2a. Sonograms show a thin fluid layer (6 mm) visible during inspiration (left image, calipers). Pleural effusion became much more apparent during expiration and allowed the reliable diagnosis (right image, calipers).

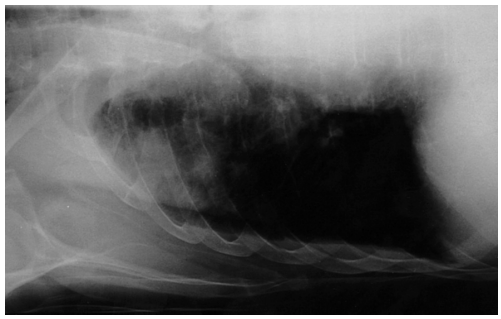

Figure 2b. Lateral expiratory decubitus radiograph, clearly showing a horizontal fluid layer of approximately the same thickness in a 52-year-old male patient with obstructive pneumonia of the right upper lobe due to lung cancer.

With the advent of sonography it was shown that very small amounts of pleural fluid can be demonstrated this way.[4-8] However no one precisely determined the sonographic criteria that should be fulfilled for reliable diagnosis of small pleural effusions. In our study population all effusions were anechogenic, the only case with hypoechogenic »fluid« turned out to be pleural thickness. Interestingly, the main sign, allowing the demonstration of the smallest effusions on sonography as well as on radiography,[17] was changing of the fluid layer during inspiration - expiration (Figures 2a, 2b).

In the course of our study searching for small pleural effusions of about 200 ml or less,[12,18] we have achieved comparable results using sonography and radiography, but sonography appears to assess the thickness of fluid layer more accurately.

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