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review

Imaging of small amounts of pleural fluid. Part two - physiologic pleural fluid

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Background. *There are only a few articles reporting the possibility of radiographic and sonographic detection of physiologic pleural fluid in healthy individuals. In the last decade the advent of sonographic equipments enables the detection of small amounts of physiologic pleural fluid in about 20% of healthy individuals. In certain physiologic conditions (i.e. pregnancy) the physiologic pleural fluid could be detected more frequently by chest ultrasonography.*

Conclusions. *A positive result, if detected, should not be taken as a sign of the occult thoracic disease.*

Key words: pleura; pleural effusion; radiography, thoracic

Introduction

The pleural space is the extremely thin, well-defined liquid space which facilitates the sliding of lung within the chest cavity. A small amount of fluid in the pleural space acts as an efficient lubricating layer which minimizes energy losses during the respiration and maximizes the transmission of forces from the chest wall to the lung.[1]

Limited studies in healthy human volunteers indicate that the volume of fluid is generally no more than 5 ml, but may be as much as 15 to 20 ml.[2] In a recent report Noppen *et al.*[3] showed that the amount of pleural fluid in a single pleural space is 4 to 13 ml. They accessed the pleural cavity in 34 otherwise healthy subjects treated with thoracoscopic sympaticolysis for the severe essential hyperhidrosis.

In the literature there are only few articles reporting the possibility of imaging of physiologic pleural fluid. There are only two articles,[4,5] both over 50 years old, reporting on the use of lateral decubitus radiography for demonstrating normal pleural fluid in healthy individuals. With the advent of sonography it was shown that very small amounts of pleural fluid can be demonstrated this way.

If the amount of pleural fluid is small, it is mostly adherent to the pleural surface and for that reason it is essentially invisible by imaging methods. When the amount of pleural fluid approaches towards 15 ml, it becomes free within the pleural cavity, particularly at costophrenic recesses, around the hilar and lobar margins[6] and it then becomes potential-

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ly visible by imaging methods. There is no clear border between the amount of pleural fluid in phsyiologic and pathologic (i.e. effusion as a sign of pleural disease) conditions.

Lateral decubitus chest radiograpy

Lateral decubitus chest radiographs were used for many years for the diagnosis of small pleural effusions, but there are only two articles,[4,5] both over 50 years old, reporting on the use of lateral decubitus radiography for demonstrating normal pleural fluid in healthy individuals. Hessen[4] improved the technique with the central beam aimed at the lateral chest wall, together with the elevation of the patient's hip. He found physiologic pleural fluid layer of 3 mm or more in 12 cases of 300 healthy volunteers. The exposure in expiration is mentioned in the work of Müller and Löfstedt,[5] but apparently without gaining wider acceptance. They examined 120 healthy persons by their method and observed fluid in 11 cases. They also performed thoracocentesis and found that the amount of fluid was 3- 15 ml.

Both techniques (patient's position during examination and exposure in suspended expiration) were applied in the study of Kocijančič *et al.*[7,8] in 106 healthy volunteers, but they found only one case of pleural fluid layer in the lateral decubitus position (Figure 1). So our conclusion is that *physiologic pleural fluid visible on lateral chest radiography is an extremely rare condition.* In every such case the pleural disease or pleural involvement should be considered.

Hessen[4] also examined 92 women 6 to 10 days after delivery with lateral chest radiography and found pleural fluid layer in 21 cases. This "physiologic" condition is nowadays well known as "benign postpartum pleural effusion".[9,10]

Chest ultrasonography

In the last decades ultrasonography (US) of pleural space becomes a leading real-time method for demonstrating small pleural effusions.[11-15]

Kocijančič *et al.*[7] in a preliminary study of 106 healthy volunteers showed that physiologic pleural fluid layer of 2 mm or more could be detected in experimental conditions in 25% of persons. They performed chest US of the lower pleural space throughout a 15 by 20 cm opening in the special examination table after 5 minutes leaning in the lateral decubitus position, the same position as in lateral decubitus chest radiography. In decubi-

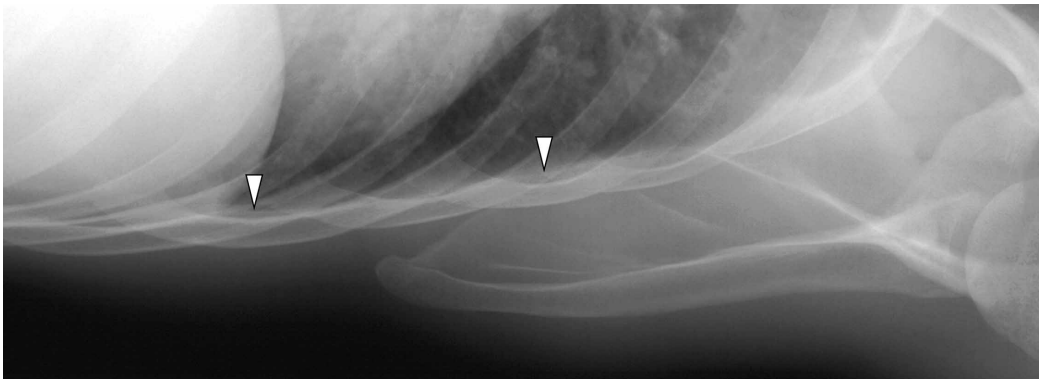

Figure 1. Left lateral decubitus expiratory radiograph showing 3 mm thick density with horizontal level (arrowhead over phrenicocostal sinus), consisting with criterion defining pleural fluid. Medial margin of the scapula should not be missinterpreted as pleural fluid accumulation (arrowhwead at the level of 4th rib).

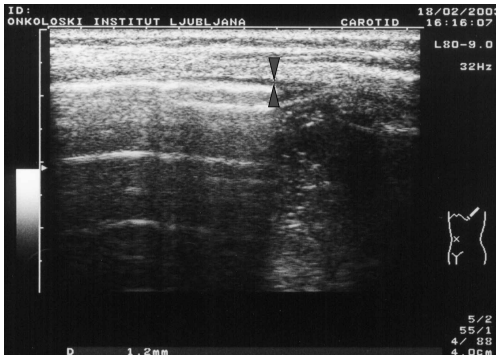

Figure 2a. Sonographic examination of the left pleural space in decubitus position. After 2 minutes laying less than 2 mm thick anechoic fliud layer (between arrowheads) appeared.

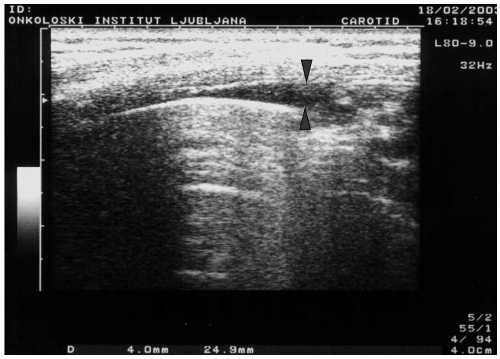

Figure 2b. Sonographic examination of the left pleural space in decubitus position. Three minutes later typically wedge-shaped 4 mm thick fluid layer was observed (between arrowheads)

tus position the pleural space was interrogated several times searching for the fluid accumulation (Figure 2). They repeated the examination of lower pleural space with the subject leaning on the elbow, still in the lateral decubitus position. In this so called "elbow position" (Figure 3) there were no instances in which fluid was only detected whilst in the lateral decubitus position.

In the follow up study they repeated chest US on each subject after two to four months.[16] They suggest that there are individuals with US permanently less ("dry pleural space") or more ("wet pleural space") physiological pleural fluid (Figure 4).

In these reports they determined US criteria for phsiologic pleural fluid: *at least 2 mm thick (but not exceeding 5 mm) anechogenic zone between the parietal and the visceral pleura and/or changing of fluid layer thickness between expiration and inspiration as well as changing with different positions of* the patient.[7,16]

In the majority of cases (75%), physiologic pleural fluid has wedge-shaped appearance on chest US (Figures 3, 4), while in the remaining cases anechoic fluid was visible between two parallel pleural lines. As the US examination is a real time method it is very important that all sonographic measurements with the probe perpendicular to the thoracic wall should be done.

Results of a pilot study of pleural space US in 47 healthy pregnants by Kocijančič *et al.*[17] confirmed physiologic pleural fluid in 60% of perfectly health pregnants. Such a positive result, if isolated, should not be taken as a sign of occult thoracic disease (Figure 5).

Conclusions

The physiologic pleural fluid could evidently be an important source of error in the diagnosis of pleural effusion by imaging methods, at first by chest US.

In the cases of the so called "wet pleural space" chest US showed the fluid layer more accurately than radiography does. The possi-

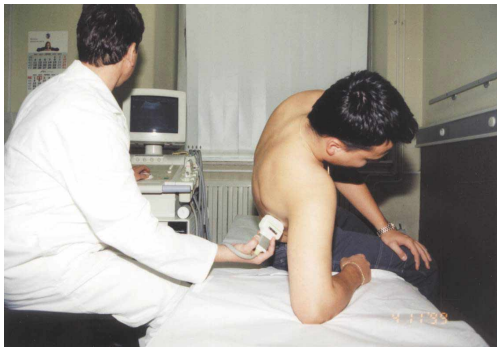

Figure 3. A photograph showing the position of the patient, the probe and the examiner during the examination of the right pleural space.

Figure 4a. US examination of the right pleural space in the elbow position. A baseline study showed typically wedge-shaped 3 mm thick fluid layer (between calipers).

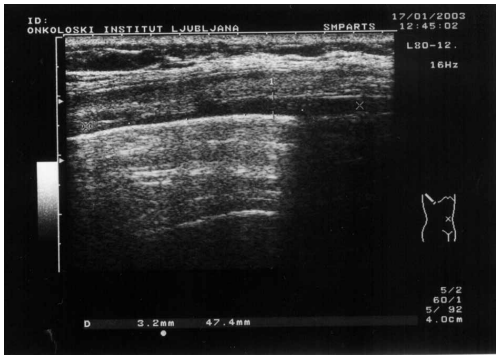

Figure 4b. US examination of the right pleural space in the elbow position. In the follow up study three months later the fluid layer (between calipers) of almost the same thickness was found.

ble reasons are: flexibility of US perpendicular approach compared to chest radiography in which the beam is tangential, clear US contrast of pleural fluid compared to adjacent structures (radiographically the density of the fluid and the bone are very near) and technically improved ultrasound scanners.

Chest US should be introduced for patients with diseases frequently affecting pleura, such as systemic connective tissue diseases and certain neoplasms. The aim of such examination would be to establish the baseline status of pleural space (e.g. if visible pleural fluid is present before the treatment). The subsequent examination in the case of disease progression would thus enable us to identify small pleural effusion as an early sign of pleural involvement.

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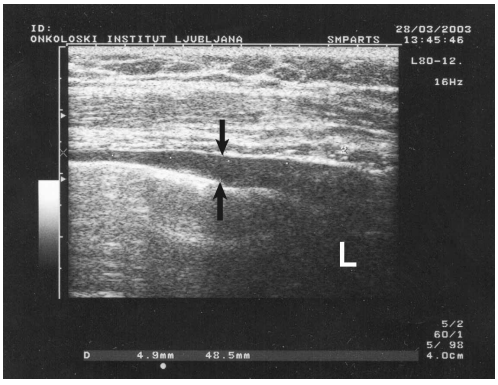

Figure 5a. US of the right lower pleural space in a sitting position. Approximately 5 mm thick pleural fluid layer (between arrows); L=liver.

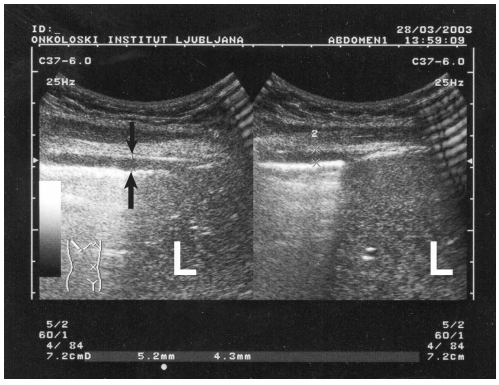

Figure 5b. US of the right lower pleural space in a sitting position. Detection of fluid using abdominal large radius convex probe (between arrows); L=liver.

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