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Case Report

Identify The Type of Pleural Effusion with Lung Ultrasound: A Case Report and State-of-Art

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ABSTRACT

Pleural effusion is the most common pleural pathology and is seen in a large group of patients admitted to internal medicine wards.
The purpose of this state of art literature review is to describe the various ultrasound fin dings that can be observed, to highlight the ability of lung ultrasound to facilitate differential diagnosis by pointing to a specific type of effusion and its cause.
To this end, the clinical case description aims to demonstrate the above and promote the use of bedside lung ultrasound by considering this technique as the fifth physical examin ation technique after inspection, palpation, percussion and auscultation.

Keywords: Bedside examination, Malignant Pleural Effusion, Point of Care Lung Ultrasound, Swirling pattern

INTRODUCTION

For many years the lungs and pleura were not considered organs that could be explored with ultrasound. The presence of air makes the images reproduced on the screen “artifactual” (A-lines, B-lines etc). Ultrasonography performed on other parts of the body is, on the other hand, a “morphological” ultrasound, that provides a very accurate image of the organ being examined.

In recent years, numerous studies have been conducted on the physical nature underlying these pleuropulmonary artifacts, have enabled us to understand the biological mechanisms of their origin and ultimately – to make lung ultrasound (LUS) a fundamental point-of-care examination.(1) Ultrasonography applied to the study of a pleural effusion (PE) is largely 'morphological ultrasound', in that it returns a clear image of the presence of the fluid, but it also has an 'artifactual' component that can help identify the type of effusion and its cause.

In this article, we discuss a clinical case in which bedside-chest-ultrasound enabled us to suspect a clear etiology of a patient's pleural effusion and guide the therapeutic procedure. Finally, a literature review is presented regarding the sensitivity of chest ultrasound in identifying the type of effusion based on ultrasound patterns.

C A S E I L L U S T R A T I O N

An 88-year-old man was admitted to the Respiratory Failure Unit for worsening dyspnea and unilateral pleural effusion identified on chest X-ray. The man was already being followed at the pneumology outpatient clinic for diffuse centrilobular emphysema and a history of occupational exposure to pneumotoxic substances. Specifically, the man had worked as a welder since his youth. Early in his career, he worked with asbestos for construction purposes and then in asbestos abatement.

On admission, the patient complained of severe right chest pain and appeared tachypneic during high-flow nasal cannula (HFNC) oxygen therapy with a FiO2 of 40%. He was apiretic and hemodynamically stable (blood pressure 140/70 mmHg, heart rate 73 bpm, normal peripheral pulses). Physical examination revealed rhythmic cardiac activity and disappearance of right basal breath sounds. Chest X-ray documented a pleural effusion mainly on the right side and areas of increased radiodensity on both pleural surfaces.

Bedside ultrasound was performed to exclude with greater confidence a pneumothorax and to examine the effusion. Lung ultrasound showed no evidence of pneumothorax but identified an effusion with a specific pattern called 'swirling', shown in Figure 1. The presence of small 'particles' (hyperechogenic compared to the fluid they were in) that floated - appeared and disappeared - was observed. This artifactual finding is also referred to as the 'plankton sign'.

Moreover, hyperechogenic plaques were clearly visible on both visceral and diaphragmatic pleural surfaces, with a tendency to coalescence. At this point, a possible malignant origin of the pleural effusion was suspected. In addition, based on the specific pattern and clinical history, a hemothorax rather than an exudate was suspected. This element indicated that although effusion was not abundant, placement of a chest drain was preferable to thoracentesis. A medium-sized (18-gauge) chest catheter was placed in the right pleura. Approximately 500 mL of blood fluid was drained per day and gradually there was an improvement in gas exchanges.

A chest-CT scan with contrast was performed to assess any active bleeding foci and/or the presence of a primary neoplastic lesion. Figure 2 shows three images of the upper - middle and lower lung fields, demonstrating diffuse calcifications, emphysema and pleural effusion. No actively bleeding vascular lesions or clear signs of tumor were noted.

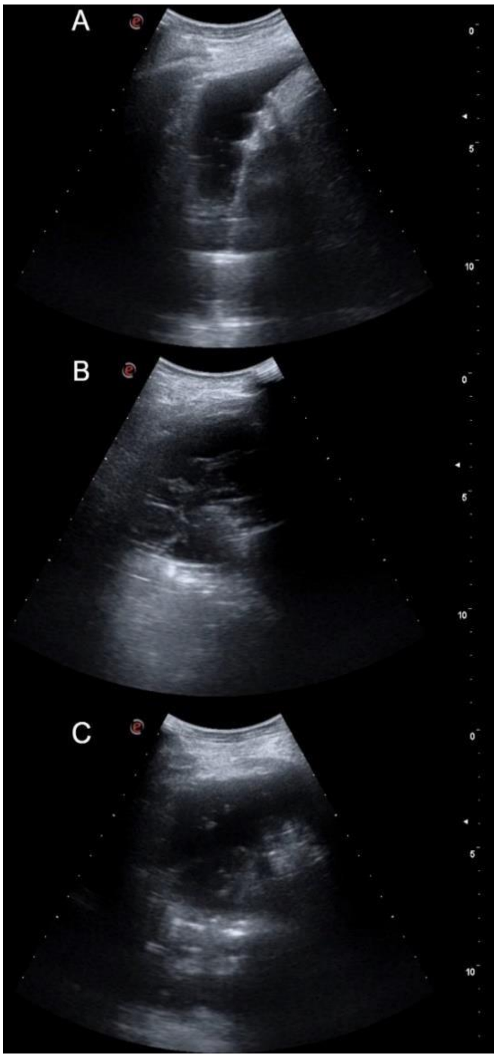

Figure 1. A) Plankton sign and calcific plaque on diaphragmatic pleura; B) Complex septated effusion C)Plankton sign.

Although the suspicion of neoplastic disease remained, given the patient's age, concomitant diseases, and severity of respiratory failure, it was decided to avoid further surgical exploration. In conclusion, the patient was ultimately discharged without chest drainage, after the absence of further fluid/blood was confirmed.

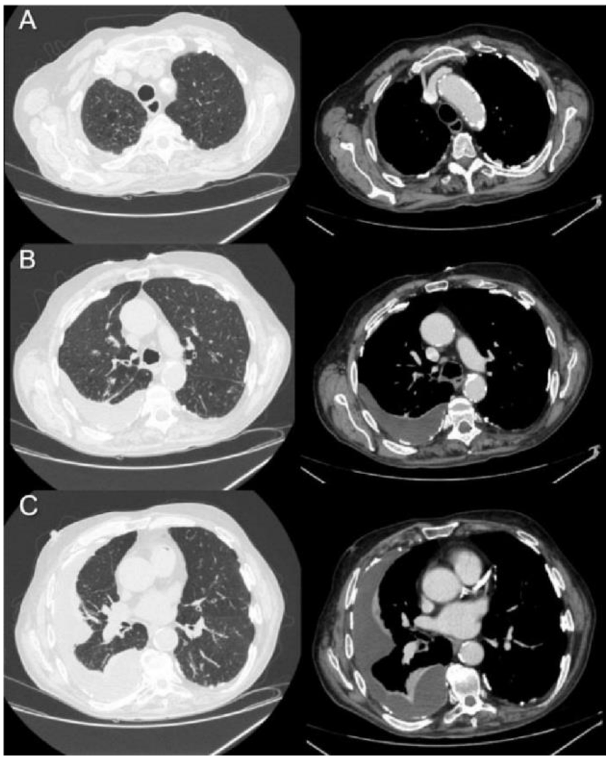

Figure 2. Chest-CT-scan with comparative lung and mediastinal window. Pleural effusion mainly on the right and diffuse pachypleuritis. A) Upper lung field B) Middle lung field C) Lower lung field.

DISCUSSIONS

Diagnosis

PE represents the most common manifestation of pleural pathology. It results from a disturbance in the balance between production and reabsorption of pleural fluid, which may have many causes. The most common cause is increased capillary hydrostatic pressure due to heart failure. Decreased colloid-osmotic pressure, as occurs in hypo-albuminemia or nephrotic syndrome, may be another cause.

Moreover, it may be due to increased capillary permeability as in the case of inflammation (neoplasia, empyema, pneumonia) and passage of peritoneal fluid through the diaphragm (ascites). Two main categories are distinguished: transudates and exudates. The etiologic classification is completed by hemothorax (as in this case report) and chylothorax.

Aspiration of the fluid and its analysis are used to determine the exact nature of the effusion. According to Light's criteria an exudate is present when the ration of protein (or LDH) in the pleural fluid to plasma is greater than 0.5. In one study LUS was considered as an alternative to invasive procedures.(2)

Indeed, LUS can determine the nature of the effusion with a high degree of confidence. Moreover, it plays a fundamental role in identifying even small effusions.(3) In this regard, Tasci et al., conducted a study comparing the sensitivity and specificity of chest ultrasound versus physical examination, X-ray, and chest-CT scan.(4) In the study, 55 patients scheduled for chest CT were identified for the diagnosis of major respiratory diseases: interstitial syndrome, pleural effusion, lung consolidations and pneumothorax. All were examined first with ultrasound, which showed a diagnostic accuracy of 98% for PE. Linear and convex probes were compared; the linear demonstrated to have greater sensitivity in identifying small (<20 ml) effusions, the convex probe was more adequate for the study of parenchyma and/or compressive atelectasis.

It is believed that both X-ray in orthostatism and chest auscultation fail to identify effusions smaller than 300 ml.(5) Even chest CT often gives false-negative results for small effusions because the fluid - with supine position - redistributes and could lead to its identification as a pleural thickening.(6)

When the pleural effusion is large, ultrasound can observe the atelectatic lung (The Jellyfish sign can be seen in Figure 3) and in some cases even the lung hilum. However, this is the only situation in which LUS can see the parenchyma deeper than the subpleural region.

Ultrasound Patterns

As mentioned above, pleural effusion is distinguished into transudate and exudate. The sonographic finding of a transudate is the presence of a completely anechogenic space between the two pleural layers (Figure 3). Conversely, in the presence of echogenicity within the intrapleural space, the pleural effusion is definitely an exudate. However, an anechogenic effusion does not rule out an exudate, as was shown by a study that revealed 14% of anechogenic effusion cases were in fact an exudate.(2)

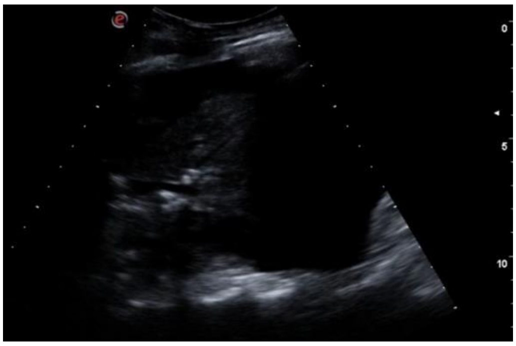

Figure 3. An anechogenic PE. Atelectasis lung (Jelly-fish sign) with fluid bronchogram sign can be seen

The sonographic classification of exudates proposed by Yang et al., is still used in clinical practice.(7) In particular, it distinguishes between effusions with complex septated, complex non-septated or diffuse homogeneous echogenic pattern. The complex septated pattern is characterized by the presence of fibrin sprouts that are clearly visible (see Figure 1 B) and often resemble alveolar structures (see Figure 4). They are caused by malignant pleural effusions (MPE) or chronic infections.(8) In other cases they are manifestations of pleural empyema or tubercular pleuritis.(9) The presence of a multiloculated effusion makes difficult to aspirate the fluid with thoracentesis, and in these cases it is often necessary to place a drain and instill fibrinolytics into pleural cavity (such as urokinase).(10)

The complex non-septated pattern is identified by the presence of focal areas of echogenicity within the fluid, which, however, does not form reticulations (see Figure 5). Homogeneous echogenicity of effusion is observed in the presence of high-density material, such as occurs with blood or pus (hemothorax, empyema). In addition to these known ultrasound findings, a new pattern has emerged in recent years, called 'swirling'.(11) This is characterized by hyperechogenic particles floating in the fluid and is mainly associated with malignancy.

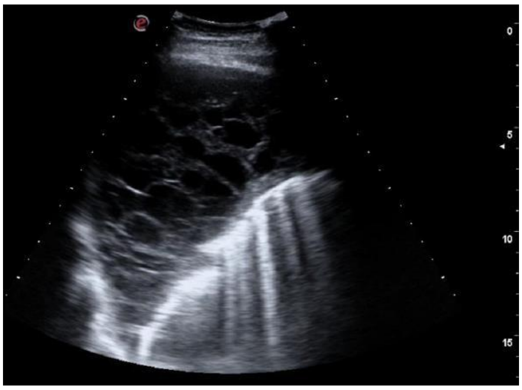

Figure 4. Complex septated effusion with multiloculated structure

Other features that may suggest MPE include visceral pleural thickness and the presence of pleural or diaphragmatic nodules with irregular borders. Finally, examination of the liver for metastases should always be included.(12) In some cases, the classic ultrasound image of an effusion is altered by the possible presence of air component (pyothorax and hydropneumothorax). In these situations, the gas is deposited upward and a sign called "hydropoint" is seen.(13) The hydropoint refers to the fluid/air interface and has the same specificity as the lung point (which identifies the air/ air interface) in diagnosing pneumothorax.

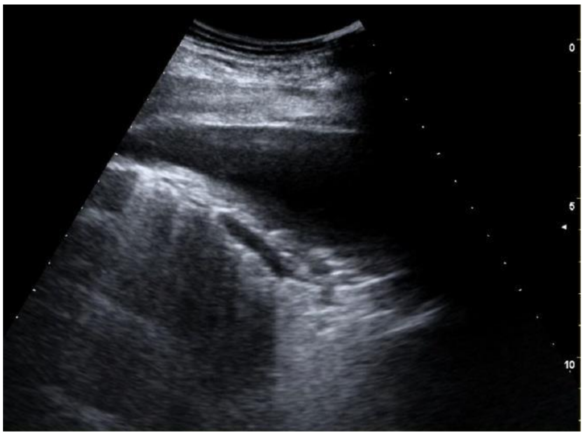

Figure 5. Complex non septated PE. Fine point echogenicity and a small subpleural consolidation are observed.

Future Prospectives

The increasing use of contrastenhanced ultrasound (CEUS) opens new diagnostic and therapeutic scenarios. Several studies have proposed the use of contrast to increase the sensitivity of ultrasound in identifying malignant pleural effusions.(14) In such cases, especially when the effusion is large and accompanied by compression phenomena, the tumor, otherwise undetectable by B-mode ultrasound, can be seen in the context of lung atelectasis.

Other applications that can be revealed by enhancment patterns are lung abscesses, which when perforate the pleura are associated with complex effusions. The absence of enhancement on ultrasonography can also be detected in pulmonary infarcts.(15) In some cases, subpleural infarct areas may be associated with pleural effusion, have triangular morphology, and even be mistaken for neoplasms on the chest CT. CEUS may be a thorough investigation, in these cases.

Finally, CEUS further improves performance in guiding interventional procedures on the pleura. A related study demonstrated improved localization of fibrous septa and thoracic catheter in the management of complex septated effusions.(16)

CONCLUSION

Ultrasound is a quick and inexpensive tool that allows usus to make clinical decisions at the bedside, guide interventional procedures, and monitor over time without exposing ionizing radiation.(17-19) There are several ultrasound findings of PE that, in conjunction with clinical symptoms and history, lead to the diagnosis. The sonographic finding of "swirling pattern," although also described in patients with transudative pleural effusions, is classically associated with MPE.(11) In this clinical case, it was associated with a hemothorax of probable neoplastic origin.

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