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Visual Case Discussion

Detection of a pulmonary mass using lung ultrasound in pre-hospital care

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1. Discussion

Although lung ultrasound (LUS) has limitations in detecting pulmonary masses, especially small or deep-seated lesions that may be obscured by rib shadows or lung air content, screening ultrasound can still be a valuable tool for identifying these abnormalities in pre-hospital settings. It is especially helpful in situations where advanced tests like detailed blood analyses, biopsies, and the gold standard of computed tomography (CT) scans are not available. This portable, quick, and non-invasive technology can play a key role in detecting serious conditions and ensuring patients are referred to specialized care without unnecessary delays.

LUS can reveal key signs of pulmonary masses. These signs often include abnormal areas in the lung that appear anechoic or have mixed echogenicity, which can vary in shape and size.[1] These masses typically have a different movement pattern compared to normal lung tissue. Unlike the more echogenic and deformable appearance of a collapsed lung, pulmonary masses are non-deformable during the respiratory cycle.[2] Additionally, the presence of solid lung tissue (consolidation) and trapped air patterns can be seen, with echogenic spots helping distinguish masses from normal or pathological lung structures.

Often, ultrasound is only able to detect these masses because of the acoustic window created by pleural effusion (PE). PE acts as a sonographic window, allowing for better visualization of the underlying masses. The nature of the pleural fluid, whether it is transudate or exudate, can also provide helpful clues. Exudates typically appear with a heterogeneous echogenic pattern, with internal echoes or septations, indicating the presence of proteins, cells, or fibrin. In cases of empyema, infection, or malignant effusions, ultrasound may reveal septations or compartmentalization within the fluid. Exudative effusions often have a speckled appearance, suggesting suspended particles, while transudates usually appear as clear, anechoic fluid.[3]

2. Visual case discussion

A 64-year-old male patient presented to a basic emergency service, presenting with complaints of cough with hemoptysis and a 15-day history of dyspnea. The case was classified as yellow on the Manchester Triage Scale. The patient had no recent episode of similar symptoms. The patient's SpO2 on room air was 98 %, pulse rate 78 bpm, and blood pressure 130/80 mmHg.

The doctor requested a thoracic X-ray (Fig. 1), which demonstrated significant left PE. The sonographer autonomously performed ultrasound and evaluated the triad inferior vena cava (IVC), heart and lung. The decision was driven by the need to refine the etiology of PE detected on chest X-ray. On the ultrasound image, the effusion presented a speckled and echogenic appearance, indicating particulate material in suspension. The inferior lung lobe collapsed and floating in PE. A nodular-like mass image was observed in the perihilar left zone near the heart. The IVC assessment was crucial in ruling out cardiogenic and transudative causes, particularly in a patient without clear clinical signs of cardiac dysfunction. IVC assessment, cardiac imaging, and

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approximate mass measurement are depicted in the supplementary materials appendix.

A biplanar sonographic approach is depicted in **Video 1** through loops **A** and **B**, reflecting the non-pure nature of PE. **Video 2** through loops **C** and **D** translates the elevated position of the nodular-like mass image, including its echogenicity and movement behavior associated with the collapsed lung. Proximity to the heart can also be seen.

After obtaining imagological findings in the basic emergency service, the doctor decided to refer the patient to a reference hospital for complementary studies. Complete blood analyses revealed abnormal values in leukocytes (18.4×10^9/L; normal range 4.0–10.0), neutrophils (15.5×10^9/L; normal range 2.0–7.0), D-dimers (2457 ng/mL; normal range <500), C-reactive protein (62 mg/L; normal range < 5), prothrombin time (13.8 s; normal range 9.4–13.0), and troponin T (15.9 pg/mL). The patient underwent a CT scan, which ruled out pulmonary thromboembolism and confirmed the presence of a suspected mass. The patient was admitted to the pulmonology specialty department. During hospitalization, the patient worsened and required drainage through thoracocentesis. Analysis of the collected fluid confirmed the exudative nature of the effusion. A biopsy was also performed, revealing fragments of tissue with infiltration by poorly differentiated malignant neoplasia. The patient underwent a histochemical analysis, which confirmed strong positivity for neoplasia.

3. Caption for image(s) or video(s)

Caption for Figure 1 – Posteroanterior chest X-ray, showing left lateral costophrenic and cardiophrenic effacement.

Caption for Video 1 – Video loops **A** and **B** depict the ecogeographic characteristic of pleural effusion in the longitudinal and axial planes, respectively. HE (heart); PE (pleural effusion); SP (spleen). A linear hyperechoic structure (indicated by the blue arrows) is visible, consistent with a fibrin strand resulting from protein and fibrin deposition in the context of an exudate; however, we also cannot exclude that it could be the inferior pulmonary ligament.

Caption for Video 2 – Video loops **C** and **D** depict longitudinal and recurrent plane views, respectively, above the left pleural-diaphragmatic transition, revealing a nodular-like structure identified as "M", as well as its movement and close relationship with the surrounding anatomical structures. M (mass); LU (lung); HE (heart); PE (pleural effusion); SP (spleen). Green arrows point to the diaphragm in movement.

4. Questions and answers with a brief rationale true & false and / or multiple-choice questions

Question 1

How should we interpret the posteroanterior thoracic radiograph in the orthostatic position, as shown in Fig. 1?

Answer Options

a) Left pleural effusion and lung mass are evident in the radiograph.
b) Left pleural effusion and consolidation are obvious.
c) Sonography is of no value in lung sonography.
d) Left pleural effusion is evident in the radiograph.
e) Computed tomography is the gold standard for effusion detection.

Correct Answer = d

Pleural effusion is evident in this radiograph; there is a clear obliteration of the cardiophrenic and costophrenic angles on the left side, with what appears to be a level outlined in the left hemithorax (arrows). Additionally, there is an unclear image of increased density superimposed over the left side of the heart. Although CT is the gold standard for lung studies, the screening for lung diseases is done through

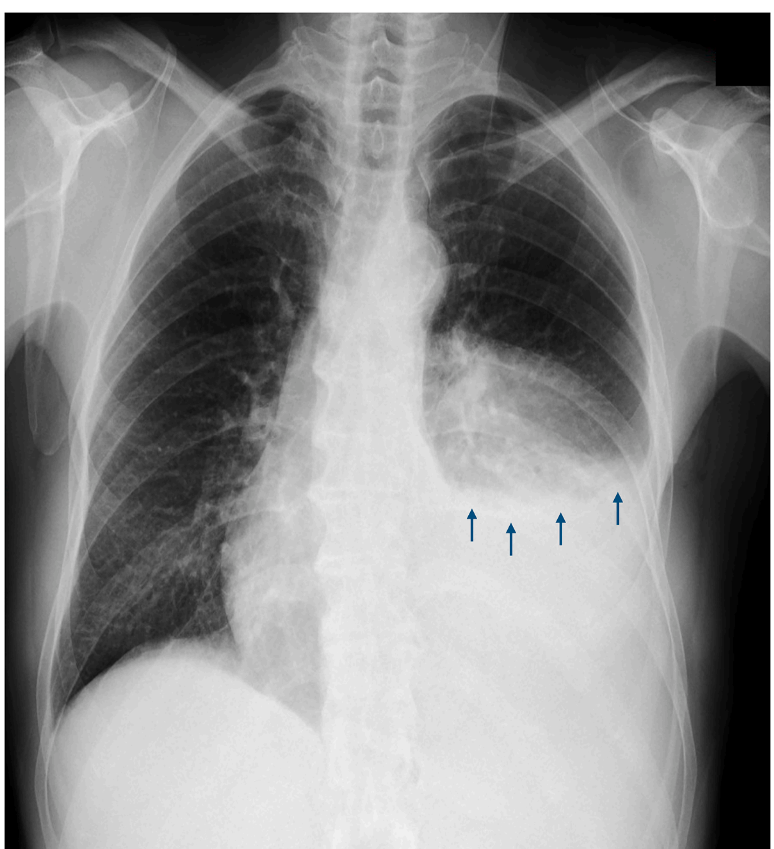

Fig. 1. Posteroanterior chest X-ray, showing left lateral costophrenic and cardiophrenic effacement.

conventional chest X-ray because it is quick, inexpensive, and has low radiation doses for the patient.

Question 2

Examine **Video 1**, composed of loops **A** and **B**. These loops represent the longitudinal and axial planes, respectively, from the left pleural-diaphragmatic transition. How should we describe the sonographic characteristics of the images observed?

Answer Options:

a) Small pleural effusion (PE) – likely transudate due to its pure, homogeneous, anechoic echogenicity.
b) Large PE – likely transudate due to its pure, anechoic echogenicity.
c) Moderate to large PE – likely exudative due to its impure nature and increased echogenicity.
d) No pathological findings above the diaphragm.
e) This effusion is not concerning due to its size and transudative nature.

Correct Answer = *c*

In PE imaging, echogenic features are often linked to exudative effusions due to cellular debris, protein, and inflammatory material, which reflect ultrasound waves more intensely, creating a hyperechoic appearance. In contrast, transudative effusions are typically anechoic or hypoechoic. Medium or large PE shows significant fluid between the pleurae, occupying part or most of the lung, with varying lung collapse. Partial lung compression may appear hyperechoic at the fluid's periphery, and the fluid remains mobile with respiration.

Question 3

Video 2

How would you describe the structure identified as "M" in **Video 2**, composed of loops **C** and **D**?

Answer Options

a) Both loops **C** and **D** depict a collapsed lung, floating within the pleural effusion.
b) "M" is compressible during respiratory movement.
c) It is probably a pulmonary mass, with movement and echogenicity unlike the collapsed lung.
d) "M" cannot be differentiated from the heart in loop **D**.
e) Lung masses have equal echogenicity as the collapsed lung; differentiation is impossible.

Correct Answer = *c*

The nodular image identified in loops **C** and **D** of **Video 2** represents a lung mass that behaves non-compressively during the respiratory cycle, in contrast to the behavior of the collapsed and floating lung in pleural effusion. The echogenicity of the mass (more anechoic) and collapsed lung (more echogenic) are distinctly separated. In loop **D**, the mass is seen in proximity to the heart.

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Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT to translate from Portuguese to English. After using this tool, the authors reviewed and edited the content as needed, and they take full responsibility for the content of the publication.

CRediT authorship contribution statement

Sérgio Miravent: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Teresa Figueiredo:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation. **Bianca Vicente:** Writing – review & editing, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.visj.2025.102228.

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