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Case Report

Diagnosis of non-expandable lung using thoracic ultrasound

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ABSTRACT

Non-expandable lung (NEL) commonly occurs secondary to chronic pleural processes, including pleural effusions, endobronchial obstruction, atelectasis, or chronic pleural inflammatory processes. Patients with NEL frequently undergo unnecessary procedures (e.g., thoracentesis), resulting in pneumothorax and discomfort (usually chest pain). Identifying a chronic process and likely development of NEL may prevent this. Diagnostic modalities currently used in practice include pleural manometry and ultrasonography. This case report demonstrates that blunting of transmitted cardiac impulse on M-Mode of ultrasonography predicts the presence of NEL.

1. Introduction

Non-expandable lung (NEL) is defined as the failure of the lung to conform to the chest wall. NEL is caused by endobronchial obstruction, visceral pleural fibrosis, and chronic atelectasis [1]. NEL can be diagnosed using pleural manometry or clinical/radiographic features after thoracentesis [2]. The present case illustrates the use of bedside ultrasound (US) to identify NEL prior to thoracentesis. Diagnosing NEL prior to thoracentesis may help make an informed decision about the placement of an indwelling catheter or pleurodesis in a patient with malignant pleural effusion (MPE).

2. Case presentation

A 65-year-old man with recent diagnosis of small cell lung cancer presented with several days of worsening shortness of breath. One month ago he was diagnosed with small cell lung cancer causing MPE. During previous hospitalization, 1.5 L of pleural fluid was drained with relief in his dyspnea. During current presentation, he denies any fever, chills, productive cough or chest pain. Review of system was otherwise unremarkable. On examination, he was afebrile, hemodynamically stable, and tachypneic with a respiratory rate of 26 with an O₂ saturation of 98% on room air. Chest examination showed decreased air entry on auscultation of the left hemithorax, with dullness on percussion. Computed tomography (CT) of the chest revealed a large left central lung mass and a large left pleural effusion. Thoracic US showed the presence of a large anechoic space in the left thorax. The patient was asked to hold his breath for 5-seconds after normal exhalation in the sitting position, and M-mode was performed. M-mode revealed a decreased lung displacement from transmitted cardiac impulse illustrating reduced cardio-phasic variability [Fig. 1].

Given the recurrent pleural effusions, the patient underwent placement of an indwelling pleural catheter (IPC) under ultrasound guidance. A total of 1200mL of serous fluid was drained using a Pleur-evac drainage device. A post-procedure chest radiograph re-

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Fig. 1. Transthoracic ultrasonography obtained during breath hold, with the utilization of M-mode, detected blunted lung displacement (0.07 cm) to transmitted cardiac impulse.

vealed a moderate-sized pneumothorax [Fig. 2]. Despite the presence of pneumothorax, he remained asymptomatic and hemodynamically stable. A chest radiograph obtained one week later showed complete resolution of pneumothorax [Fig. 3] and evidence of volume loss.

3. Discussion

The present case demonstrates the utility of US in predicting the occurrence of NEL before thoracentesis. Presence of NEL is clinically relevant because pleurodesis is contraindicated in patients with MPE who have NEL [3].

NEL is common in MPE, with a prevalence ranging anywhere between 30% and 50%, explaining the low success rate of pleurodesis in these patients (<50%) [4]. Pleural effusions that form in association with NEL can be explained by the formation of a fibrous peel on the visceral pleura. This thickened pleura prevents the lung from expanding and conforming to the shape of the thoracic cavity, which in turn creates a negative pleural pressure and induces entry of fluid into the pleural space. The negative pleural pressure also leads to impaired lymphatic drainage, causing the development of pleural effusion.

Drainage of pleural effusion in patients with NEL results in deformation of the underlying lung parenchyma, which opens a transient pressure-dependent alveolar-pleural fistula, leading to the formation of pressure-dependent pneumothorax (PTX). These pneumothoraxes are the result of drainage-dependent air leaks, and do not occur unless drainage of fluid occurs [4]. The implication of the drainage-dependent nature means that this process does not progress to tension pneumothorax. Therefore, drainage of air is not necessary. Furthermore, this air leak is pressure-dependent and only occurs when there is a pressure gradient between alveoli and the pleural space (e.g., coughing or external application of suction) [1,5].

Pre-procedural diagnosis of NEL helps avoid pleurodesis in patients with MPE as it is contraindicated in the presence of NEL. Additionally, knowing that NEL is present avoids unnecessary chest tube drainage in cases where PTX may develop after pleural fluid



Fig. 2. Chest radiograph after IPC placement showing development of left sided hydropneumothorax.

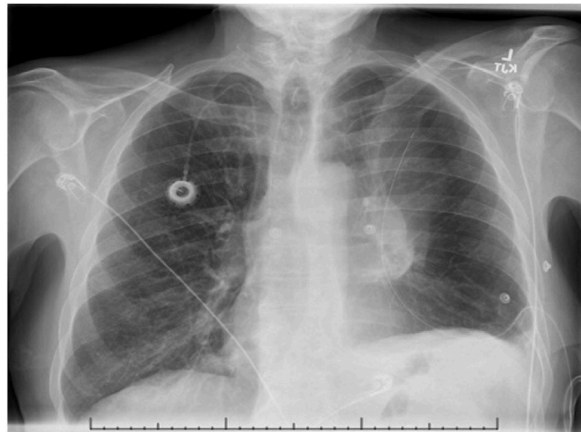


Fig. 3. Chest radiograph after one week showing volume loss on the left side.

drainage. Traditionally, NEL is diagnosed using continuous pleural manometry in conjunction with post thoracentesis chest radiography. Recent studies suggested that thoracic ultrasound can be used before thoracentesis to identify NEL. A prospective study by Salamonsen et al. utilized M-mode to measure the degree of displacement of the atelectatic lung caused by the transmitted cardiac impulse in a cardiac cycle during a breath hold. In this study, blunted displacement (< 0.8 mm) was highly specific (specificity 85%) for the diagnosis of NEL [6]. In the current case there was complete blunting of the cardiophasic variability, which was highly suggestive of NEL. Post-procedure CXR showed *pneumothorax ex vacuo* which resolved spontaneously after one week. Follow up CXR showed volume loss further supporting the evidence of NEL.

4. Clinical pearls

1. Non-expandable lung (NEL) is a common occurrence in patients with malignant pleural effusion that affects treatment and prognosis.
2. Identifying NEL has clinical relevance, as pleurodesis is contraindicated for malignant pleural effusion when NEL is present.
3. Ultrasonography can help identify the presence of NEL prior to thoracentesis in patients with malignant pleural effusion

Ethical publication statement

We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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Declaration of competing interest

None of the authors have any conflict of interest.

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