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Case Report

Lung Ultrasonography for Pulmonary Atelectasis in a Child

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Abstract Pulmonary atelectasis in children is a pathological condition with no specific symptoms or findings that may be seen in the course of several pulmonary and thoracic diseases. Early and accurate diagnosis is essential in the treatment of pulmonary atelectasis. The first imaging method to be considered when a patient with pulmonary atelectasis is encountered is posterior-to-anterior chest X-ray. However, several pulmonary diseases can today be diagnosed and monitored using bedside ultrasonography. We describe a case of peripherally located radio-opacity in the right upper zone at posterior-to-anterior chest X-ray in a 9-year-old patient under monitoring due to asthma and presenting with cough and nasal discharge. Images compatible with atelectasis were obtained at pulmonary evaluation with bedside ultrasonography. No atelectatic areas were observed at control ultrasonography and posterior-to-anterior chest X-ray following appropriate treatment. Lung ultrasonography is an imaging technique that is especially promising in children and that may represent an alternative in the diagnosis and monitoring of pulmonary atelectasis.

Key words Atelectasis; Lung ultrasound; Paediatric

Introduction

The identification of pulmonary opacities using chest X-ray may sometimes be problematic for clinicians. The two most common causes of pulmonary opacities are pneumonia and atelectasis.[1] Atelectasis represents the loss of pulmonary volume in association with parenchymal compression (non-obstructive atelectasis) or partial or complete obstruction of the airway in the bronchial tree.[2] Atelectasis compromises respiratory functions by affecting the ventilation-perfusion balance. It can increase the risk of pneumonia by reducing ventilated pulmonary tissue. Pulmonary atelectasis in children can develop in association with several pulmonary diseases and occurs through three main mechanisms; (i) air passage obstruction, (ii) defect in extrathoracic, intrathoracic or chest wall structures or pulmonary parenchymal compression due to neuromuscular disease, or (iii) surfactant insufficiency or dysfunction.[3] No symptoms or findings specific to pulmonary atelectasis develop in many patients. Fever, cough, tachypnoea, wheezing, rhoncus and chest pain are commonly seen symptoms and findings in pulmonary atelectasis and in other respiratory conditions. So long as the atelectatic area is not extensive, the presence of pulmonary atelectasis does not alter the clinical condition.[3] The primary imaging method in the diagnosis of pulmonary atelectasis is posterior-to-anterior chest X-ray. The extension of the atelectatic area can be determined with posterior-to-anterior and lateral X-rays, but it is difficult to make this distinction in some conditions, particularly pneumonia, and another

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imaging technique is required for confirmation. Indeed, peripherally located manifestations can be confused with pneumonia or other space-occupying lesions. The use of assessment with bedside ultrasonography, and particularly lung ultrasonography, is increasing by the day in emergency and intensive care units. Lung ultrasonography can assist with the diagnosis of pleural effusion, pneumothorax, pulmonary consolidation, interstitial syndrome, interstitial lung disease, atelectasis and other causes of pulmonary and non-pulmonary dyspnoea.[1,2,4,5] Biconcave structures with distinct margins can be seen by ultrasonography in non-obstructive atelectasis. The acoustic pattern is a moderate echogenic appearance with air trapping. The parenchyma generally appears hypoechogenic. Atelectatic lung tissue may collapse during inspiration and expand again, and atelectasis may temporarily disappear. Simultaneous or secondary pneumonic consolidation may also be observed. A convex appearance on the atelectatic margin with an increase in lung tissue volume, or different appearances associated with respiration may be seen. Obstructive atelectasis frequently develops in association with obstruction in the distal part of the airway (bronchial carcinoma, mucus plug). Images are less dependent on respiration. Echogenic air contents and vascular structures may be seen depending on the duration of atelectasis. Hepatisation and typically fluid bronchograms are seen in the event of post-stenotic pneumonia.[1,4]

Lung ultrasonography is becoming increasingly important in the diagnosis and monitoring of various diseases, particularly in children. We report the case of a 9.5-year-old girl under observation due to asthma in whom pulmonary atelectasis was confirmed with ultrasonography.

Case Report

A 9-year-old girl presented to hospital with respiratory difficulty and cough over the preceding 3 days. Nasal discharge and productive cough had begun 3 days previously. The symptoms had worsened over the preceding one day, and she was referred to our hospital when the physician to whom she initially presented identified opacity at chest X-ray. The patient had been diagnosed with asthma 3 years previously and had received various treatments due to occasional mild asthma attacks. Vital findings were stable at physical examination, both lungs were equally ventilated and mild wheezing was present in both. Complete blood count and biochemical tests were normal. Chest X-ray revealed a radio-opaque appearance with no air bronchograms in the region close to the midline in the right upper zone (Figure 1). Evaluation of pulmonary tissue extending vertically and horizontally between the right anterior 1st and 3rd intercostal spaces using bedside ultrasonography, revealed a hypoechoic area 7.98 cm^2 in size containing hyperechogenic components compatible with non-dynamic air bronchograms and occasionally increased B-lines (Figure 1). Ultrasonography was performed by the first author (AKÖ) using a SonoSite Edge portable ultrasound device with a 6-15 MHz linear probe (6 cm scan depth) in B-mode. The lesion was interpreted as atelectasis, and an inhaler bronchodilator and chest physiotherapy were prescribed. Hypoechoic area was no longer observed at repeat lung ultrasonography 2 days later and radio-opaque appearance was also no longer observed in the right upper zone at repeat posterior-anterior chest X-ray (Figure 2).

Discussion

Bedside ultrasonography is not only an imaging technique but also an alternative and descriptive diagnostic tool in several pulmonary diseases. Since it is economical, portable and simple to perform, permits patient transfer and does not involve exposure to radiation, it is becoming increasingly commonly used. In terms of determining atelectasis triggered by anaesthesia, Acosta et al determined atelectatic pulmonary areas using lung ultrasonography after thoracic MRI following the administration of anaesthesia to 15 children. Taking MRI as a reference, lung ultrasonography has been shown to possess high sensitivity (88% and 95%, CI 74% to 96%) and specificity (89% and 95%, CI 83% to 94%).[6] In newborns, lung ultrasonography has been shown to exhibit 100% sensitivity for pulmonary atelectasis, compared to 75% for chest X-ray.[5] It can be difficult to differentiate between pulmonary consolidation areas and atelectatic regions using ultrasonography or chest X-ray. It may be easier to distinguish air bronchograms in extensive consolidated areas. The reflection of bronchial structures in small lesions may not be capable of identification in atelectasis and pneumonia. The appearance of bronchial structures containing air in collapsed pulmonary tissue differs from that in consolidated regions. In atelectasis, the margins of hypoechoic lesions can be clearly distinguished, bronchograms are generally stable, no centrifugal movement is observed and they are located parallel to one another. In pneumonia, however, bronchograms are generally wider, dynamic and exhibit

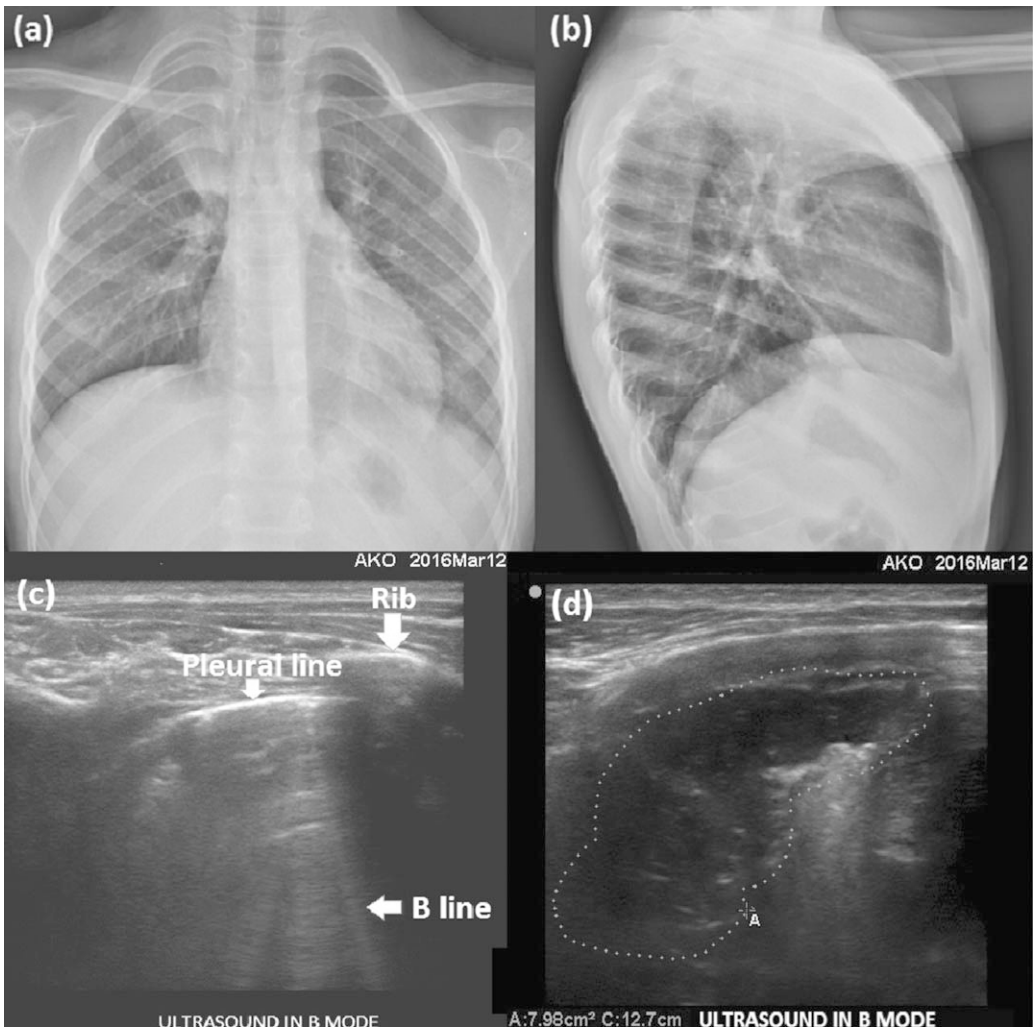

Figure 1 (a) Radio-opacity extending to the apex in the right upper zone at posterior-anterior chest X-ray, (b) radio-opaque appearance originating from the hilar region and extending to the apex. (c) B-lines tending to coalescence and (d) a 7.98-cm^2 area compatible with atelectasis at lung ultrasonography evaluation.

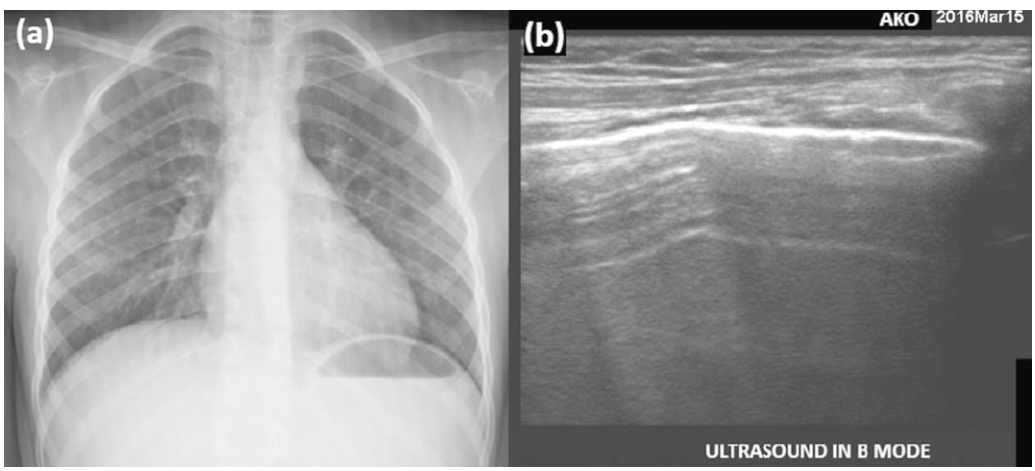

Figure 2 The previous radio-opaque appearance is no longer visible at control posterior-anterior chest X-ray (a) and there is no area compatible with atelectasis at control lung ultrasonography evaluation (b).

centrifugal movement.[1,4,6] Accompanying atelectasis with consolidation may sometimes be observed. Alveolar inflammation, increased fluid in the interstitial space, inflammation in the bronchial tree and oedema with secretion accumulation may occur in areas of pneumonia-related consolidation. In consequence, fluid accumulates inside the bronchial structures and sonographic reflections occur in the form of fluid bronchograms. Mucous plugs may forms as a result of increased fluid accumulation and debris in the bronchial structures, and obstructive atelectasis may develop together with pneumonic consolidations in association with this. Moreover, compressive atelectasis may be observed together with pleural effusion or empyema around pulmonary tissue.[6]

While lung ultrasonography is very sensitive and specific in the diagnosis of atelectasis in children, superficial pulmonary parenchyma or those close to the surface can also be evaluated with ultrasonography. However, deep lesions may not be determined during evaluation with ultrasonography. One study revealing the usefulness of lung ultrasonography in patients with pneumonia confirmed this.[7] In fact, evaluation in terms of atelectasis using ultrasonography may be advantageous due to the anatomical characteristics in children compared to adults. However, studies concerning determination of atelectasis in children using ultrasonography are insufficient in terms of numbers and quality.[5,6] In addition, the visualisation not only of deep pulmonary parenchymal lesions, but also tumours and other space-occupying lesions in the posterior mediastinum and pulmonary areas is not generally possible, due to the restricted depth penetration of the ultrasound probe, and the super imposition of acoustic shadows of osseous and other structures.[8]

In addition, lung ultrasonography can also be used in the monitoring of atelectasis as well as diagnosis. In a case report of pulmonary atelectasis confirmed by ultrasonography, Elia et al showed pulmonary re-expansion with ultrasonography following cleaning of the airways with bronchoscopy.[2] Similarly, atelectasis in a patient with postoperative pulmonary atelectasis was confirmed with ultrasonography, and improved pulmonary tissue sonographic findings were reported after treatment.[9] Lung ultrasonography appears to be useful in identifying collapsed alveoli in patients undergoing mechanical ventilation and in revealing resolution of the atelectasis.[10]

In conclusion, we think that bedside ultrasonography can be used as a simple, easy to administer and useful tool that does not involve exposure to radiation in the diagnosis and monitoring of pulmonary atelectasis in children.

Declaration of Interest

There are no conflicts of interests to be declared.

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