MEDDOCS
Open Access Publisher

ISSN: 2637-9627

Annals of Pediatrics

Open Access | Research Article

Sonographic Features of Lobar Pneumonia with Parapneumonic Effusion in Children

Chia-Wang Tang[1]; Ken-Pen Weng[2]; I-Hsin Tai[3]; Chen-Che Chou[4]; Shi-Yen Chen[4]; Kai-Sheng Hsieh[4]*

[1]Division of Pediatric Pulmonology, An-Tai Hospital, Dongkang, Pingtung, Taiwan.

[2]Department of Pediatrics, Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan.

[3]Department of Pediatrics, China Medical University Children's Hospital, Taichung, Taiwan.

[4]Department of Pediatrics, Shuangho Hospital—Taipei Medical University, New Taipei City, Taiwan.

***Corresponding Author(s): Kai-Sheng Hsieh**

Department of Pediatrics, Shuangho Hospital - Taipei Medical University, New Taipei City, Taiwan.

Email: kshsieh@hotmail.com

Received: Jan 09, 2021

Accepted: Feb 09, 2021

Published Online: Feb 12, 2021

Journal: Annals of Pediatrics

Publisher: MedDocs Publishers LLC

Online edition: http://meddocsonline.org/

Abstract

Objective: To study the sonographic features of lobar pneumonia with parapneumonic effusion in children.

Materials and methods: Retrospective review of 11 children with lobar pneumonia and parapneumonic effusion. The clinical pictures, plain chest X-rays, computed tomographic chest sonographic findings were collected and studied.

Results: Among the 11 patients with lobar pneumonia and para-pneumonic effusions, chest X-ray only showed 6 with pleural effusion. Chest sonography all showed evidence of lobar consolidation with complex septation as well as plexiform fibrin appearance within the parapneumonic effusion.

Conclusions: Pan-lobar consolidation is important for diagnosing lobar pneumonia. The presence of complex as well as plexiform fibrin formation warrants early intervention to clear the fibrin debris. Chest sonography is useful for the detection of pneumonia and parapneumonic effusion in children.

Introduction

Pneumonia causes 3 million deaths globally, or 29% of deaths annually, and is the leading cause of death worldwide among children younger than 5 years [1-3]. Lobar pneumonia with empyema has an occurrence rate of 44.9 and 10.5 episodes per 100,000 children-year, respectively, in children under 5 years old in Taiwan [4], which is much less than the described 5-10% of children with bacterial pneumonia worldwide [2]. About one in 150 children hospitalized for pneumonia suffer from empyema [5] and there is an increasing in frequency in America, Europe, and Asia. However, lobar pneumonia still causes a significant mortality rate in children, especially those under five years of age. The under-diagnosis of para-pneumonic empyema is further associated with increased morbidity and mortality.

Patients with lobar pneumonia and empyema are generally assessed by chest radiography throughout its course. In the recent 2-3 decades thoracic computed tomography has been employed more frequently for assessment. However, due to the

Cite this article: Hsieh KS, Tang CW, Weng KP, Tai, IH, Chou CC , et al. Sonographic Features of Lobar Pneumonia with Parapneumonic Effusion in Children. Ann Pediatr. 2021; 4(1): 1059.

radiation-exposure of these examinations, chest sonography has been used with its advantages of radiation-free, high portability and relatively easy operability. Since the early 1990's, chest sonography has been performed widely in adults, but much less commonly in children. Most notably, the use of chest sonography in pediatric patients with lobar pneumonia has rarely been described. This research was conducted to study the sonographic features of lobar pneumonia with parapneumonic effusion in children.

Methods

The research was conducted in a tertiary teaching hospital by reviewing the clinical records from 2011 to 2012. The eligibility criteria included people with an age of <18 years, with confirmed diagnosis of lobar pneumonia and parapneumonic effusion by chest radiography and chest Computed Tomography (CT).

Chest sonography was performed within 48 hours of admission. The exclusion criteria were age >18 years and pleural effusion secondary to autoimmune diseases, tumors, malignancy, or hepatic, renal, or cardiac disorders. All included patients had obvious clinical symptoms of lower respiratory infection .

Diagnostic thoracentesis was performed under ultrasound guidance. Pleural fluid, pH, glucose, and LDH were evaluated. The gross and microscopic appearances of the fluid were recorded. Indications for pleural drainage were purulent pleural fluid, gram stain and/or culture positive pleural fluid, positive urine pneumococcal antigen test, pleural fluid acidosis (pH<7.2), Lactate Dehydrogenase (LDH) >1000IU/l, ratio of pleural fluid to serum protein level of >0.5; ratio of pleural fluid to serum Lactate Dehydrogenase (LDH) level >0.6; and the ratio of pleural fluid and serum lactate was greater than two-thirds of the upper limit of normal for serum levels [14].

Radiography

All the patients underwent chest radiography on admission. Antero-posterior or postero-anterior, and/or lateral chest radiography were performed in the radiology department (at bedside with a portable unit) and were all analyzed by radiologists who were blinded to the ultrasound findings. The radiologists reported the presence of lobar consolidations and/or pleural effusion.

Chest sonography

Two operators performed the chest ultrasound using a commercially available sonographic equipment equipped with appropriate transducer frequency. The anterior chest area was delineated from the clavicle to the diaphragm and from the sternum to the anterior axillary line on supine position and the lateral area was delineated from the anterior to the posterior axillary line and from the axilla to the diaphragm while posterior chest area was defined from the line encircling the paravertebral line, medial lower scapular line, posterior axillary line and the lower posterior rib cage on each side on the supine, prone, sitting or decubitus position on each side. There were two experienced investigators who performed the bedside chest sonographic examinations. Chest sonography was interpreted independently from the radiographic findings.

The study was approved by the ethical committee of the institutional board.

Results

A total of 11 children with lobar pneumonia and parapneumonic effusion were recruited.

A. Performance of chest radiography and chest sonography for detecting effusions

The performance of chest radiography versus chest sonography revealed that chest sonography detected all 11 patients with parapneumonic pleural effusion. The findings were consistent with chest computed tomography. Chest radiography failed to detect 5 patients with parapneumonic effusion. There were 11 lobar pneumonia cases and 8 involving the basal area. Ten patients with at least 1 side effusion and 6 chest radiography failed to show adequate evidence of pleural effusion.

B. Specific sonographic features of parapneumonic effusion:

Chest sonography among the 11 patients with parapneumonic effusion all showed evidence of lobar consolidation (Figure 1). Lobar distribution of pan lobar area of consolidation with air-bronchogram throughout the lobar region delineating the sonographic features of lobar pneumonia. The chest sonography thus provided differentiation between pleural effusion and lobar consolidation. There was 1 patient with scanty fibrin floating within the pleural effusion (Figure 2) while all the others showed plexiform fibrin appearance within the parapneumonic effusion, some part densely packed and some part relatively loosely adhered to each other (Figure 3). All children with sonographic features of parapneumonic effusion showed effusive fluid analysis compatible with empyema. None of these patients with lobar pneumonia had simple pleural effusion without fibrin formation within the pleural cavity.

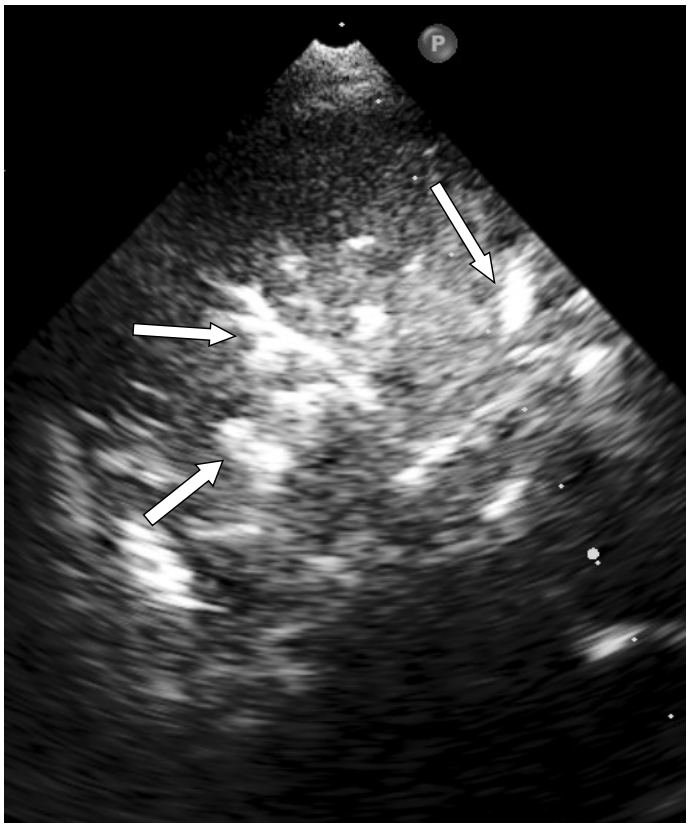

Figure 1: Chest sonographic images of lobar consolidation at right middle lobe showing diffuse lobar airbronchogram (white arrows).

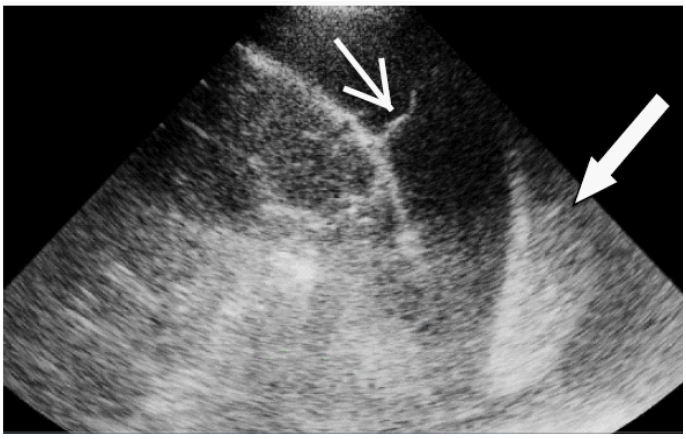

Figure 2: Parapneumonic effusion with fibrous single fibrinous strand (narrow arrow) and atelectic lung tissues (wide arrow).

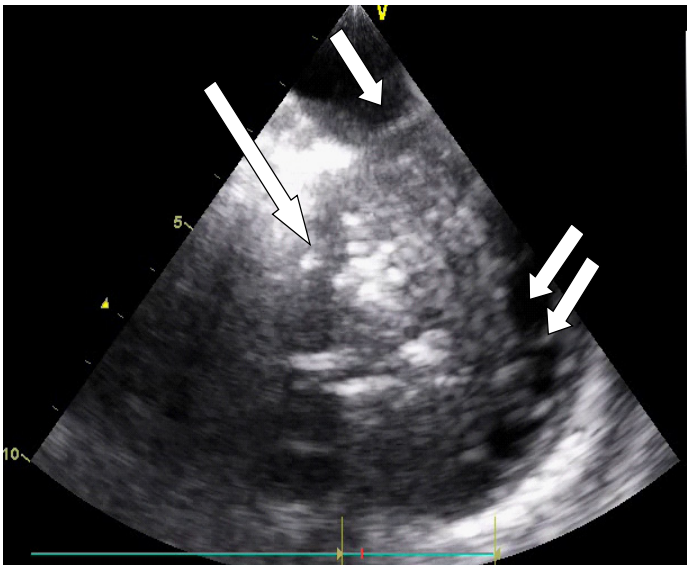

Figure 3: Lobar pneumonia with consolidated lobar lung parenchyma and many airbronchograms (long arrow) as well as plexiform fibrinous formation within the parapneumonic effusion, some part densely packed (single short arrow) and some part relatively loosely adhered each other (double short arrows).

Discussion

Empyema occurs in approximately 2% of patients with bacterial pneumonia [1]. Over 40% of patients with pneumonia develop unilateral pleural effusion and on the affected side approximately 10% of parapneumonic effusions become infected and progressed to empyema [14].

The value of chest sonography follows from the limitations of radiography and chest CT. Previous studies have shown that sonography is much more sensitive than supine chest x-ray for establishing the diagnosis of pleural effusion [12]. An average of 150 ml of pleural effusion is required for detection on a standard x-ray with a patient in standing position in adults [15]. In contrast, a minimum of 5 ml of effusion can be detected in chest sonography latero-dorsally near the diaphragm, in both standing and sitting positions [15]. Aside from the subjectivity in the interpretation of radiography,43% pleural effusion may be undetectable by chest radiography.

Additionally, in patients with lobar pneumonia, the diagnosis of pleural effusion poses another challenge, especially for children with lobar pneumonia involving the lower part of the lung lobes, the opacity with lobar pneumonia often masking the haziness of the parapneumonic fluid. This study shows that the performance of chest sonography on pleural effusion is better than conventional radiography.

Extremely small effusions cannot be detected using CT, which usually also does not visualize fibrin strands or loculations because they are too thin [3-9]. Instead, CT only provides information about abnormalities on the lung. Hence, CT imaging may not be used routinely for parapneumonic effusions unless another diagnosis is suspected (e.g., tumor or abscess) [16], especially because of concerns regarding radiation exposure on a growing child and because less invasive techniques usually suffice for diagnosis and management [9]. Therefore, CT imaging and chest radiograph often do not differentiate simple parapneumonic effusion from empyema and cannot detect dynamic changes in the lung or pleura. These changes are often best seen by chest sonography [12-13,17-18]. Sonography is also superior due to its portability, much detailed features for lung parenchymal tissue as well as intrapleural tissue depiction, non-radiation, no contrast requirement, and low cost. Most patients also do not require sedation [18]. Due to the advantages of chest sonography, more and more applications of chest sonography has been explored in pediatrics. [19-21]. However, the sonographic study of lobar pneumonia and empyema have been rarely done.

This study has several limitations. First, this is a single-center, retrospective review. Second, when using chest sonography as a routine monitoring tool, physicians should be aware of its limitations. Sonography generally sometimes is operator dependent. While its accuracy for diagnosing pneumonia with para-pneumonic effusions and empyema is clearly established, accuracy depends on the learning curve. Third, obese patients are frequently difficult to examine because of the thickness of subcutaneous tissue [22-23].

In conclusion, patients with lobar pneumonia and parapneumonic have multiple features comparable with known pathologic changes to their lung parenchyma, pleural lines and the content of pleural effusion . T he presence o f consolidation throughout the whole lobar portion of the lung with fibrin accumulation including fibrin plexus and fibrin adherence is specific of lobar pneumonia with parapneumonic effusion. T he chest sonographic findings may be useful markers for the clinical recognition and follow up of children with lobar pneumonia and parapneumonic effusion.

References

1. Rudan I. Epidemiology and etiology of childhood pneumonia. Bull WHO. 2008; 86: 408-416.
2. Kliegman R, Nelson WE. Nelson Textbook of Pediatrics. Philadelphia, PA: Elsevier/Saunders. 2011.
3. Brims FJ, Lansley SM, Waterer GW, Lee YC. Empyema thoracis: new insights into an old disease. Eur Respir Rev. 2010; 19: 220-228.
4. Wu PS, Huang LM, Chang IS, Lu CY, Shao PL, et al. The epidemiology of hospitalized children with pneumococcal/lobar pneumonia and empyema from 1997 to 2004 in Taiwan. Eur J Pediatr. 2010; 169: 861-866.
5. JR GHM. Etiology and treatment of pneumonia. Pediatr Infect Dis. 2000; 19: 373-377.
6. Jaffe A, Balfour-Lynn IM. Management of empyema in children.

Pediatr Pulmonol. 2005; 40: 148-156.

7. Walters J, Foley N, Molyneux M. Pus in the thorax: management of empyema and lung abscess. Cont Educ Anaesth Crit Care Pain. 2011; 11: 229-233.

8. Himelman BR, Callen PW. The prognostic value of loculations in para-pneumonic pleural effusions. Chest. 1986; 90: 852-856.

9. Calder A, Owens CM. Imaging of para-pneumonic pleural effusions and empyema in children. Pediatr Radiol. 2009; 39: 527-537.

10. Yu D, Buchvald F, Brandt B, Nielsen KG. Seventeen-year study shows rise in para-pneumonic effusion and empyema with higher treatment failure after chest tube drainage. Acta Paediatr. 2014; 103: 93-99.

11. Rahman NM, Singanayagam A, Davies HE, Wrightson JM, Mishra EK, Lee YG et al. Diagnostic accuracy, safety and utilisation of respiratory physician-delivered thoracic ultrasound. Thorax. 2010; 65: 449-453.

12. Lucaya J, Strife JL. Pediatric chest imaging: chest imaging in infants and children. Medical radiology, Berlin; New York: Springer. 2002; 12: 306.

13. Mayo PH, Beaulieu Y, Doelken P, Feller-Kopman D, Harrod C, Kaplan A, et al. American College of Chest Physicians/La Societe de Reanimation de Langue Francaise statement on competence in critical care ultrasonography. Chest. 2009; 135: 1050-1060.

14. Kearney SE, Davies CW, Davies RJ, Gleeson FV, et al. Computed tomography and ultrasound in para-pneumonic effusions and empyema. Clin Radiol. 2000; 55: 542-547.

15. Mathis G. Chest sonography. Heidelberg: Springer. 2011.

16. McLoud TC, Flower CD. Imaging of the pleura-sonography, CT, and MR imaging. AJR. 1991; 156: 1145-1153.

17. Tsai TH, Yang PC. Ultrasound in the diagnosis and management of pleural disease. Curr Opin Pulm Med. 2003; 9: 281-290.

18. Beckh S, Bolcskei PL, Lessnau KD. Real-time chest ultrasonography. A Comprehensive Review for the Pulmonologist. Chest. 2002; 122: 1759-1773.

19. Nilam JS, Ricardo F, Maria IV, Daniel S, Ria D, et al. Ultrasound in the Diagnosis & Management of Pleural Effusions. J Hosp Med. 2015; 10: 811-816.

20. Goh Y. Sonography of the Pediatric Chest. J Ultrasound Med. 2016; 35: 1067-1080.

21. Lichtenstein DA, Meziere GA. Relevance of lung ultrasound in the diagnosis of acute respiratory failure: the BLUE protocol. Chest. 2008; 134: 117-125.

22. Taussig LM, Landau LI. Pediatric respiratory medicine. Philadelphia: Mosby/Elsevier. 2008.

23. Bouhemad B, Zhang M, Lu Q, Rouby JJ. Clinical review: Bedside lung ultrasound in critical care practice. Crit Care 2007; 11: 205.