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Successful Conservative Management of Necrotizing Pneumonia in Pediatric Patients: Experience of Two Patients

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Abstract

Background: Necrotizing pneumonia is an uncommon, but serious complication of pneumonia in children. The indications and timing of surgical procedures are not outlined and are controversial.

Case report: In this report, we presented two pediatric cases, which be diagnosed with necrotizing pneumonia and have recognized indications for aggressive surgical operation. Nevertheless, the two patients were not treated with surgery due to their parents' concerns about complications of thoracotomy and damage to lung function and still achieved complete recovery in manifestations and radiology by conservative modalities including a lengthy course of antibiotics, bronchoscopy lavaging, thoracocentesis, and symptomatic treatment.

Conclusion: Necrotizing pneumonia can be successfully treated with a conservative treatment regimen even in patients with a recognized indication for surgery.

Keywords: Necrotizing pneumonia • Children • Surgical procedure • Conservative treatment

Introduction

Necrotizing pneumonia (NP) is an uncommon and severe complication of community-acquired pneumonia in children with an increasing incidence in recent years [1]. Infection is the main pathogenic factor of NP, especially bacterial infection, which can promote the secretion of cytokines by the host immune system. It eventually leads to massive exudation and consolidation of the lung parenchyma accompanied by necrosis and liquefaction [2].

Managing patients with NP is challenging because there are no firm guidelines outlining the management of NP. When refractory infection, septicemia, or throxatic complications such as pleural effusion, empyema, and bronchopleural fistula occurred, aggressive surgical procedures are indicated [3]. A few studies have reported that surgery can significantly relieve clinical symptoms, shorten the length of hospital stay, and improve the clinical prognosis of NP patients [4,5]. However, contrary studies suggest that surgery is unnecessary because of a high incidence of postoperative complications, such as persistent air leaks, empyema, and ventilator dependence [6]. Patients with NP can be completely resolved clinically and radiographically with medical treatment [7,8]. A lengthy antibiotics administration is the cornerstone of NP treatment.

In this paper, we presented two pediatric NP cases, who had recognized indications for aggressive surgical operation but had achieved complete recovery through a conservative treatment regimen. To our knowledge, this is the first report about the conservative efficacy with a full follow-up investigation in children with necrotic pneumonia who had definite surgical indications.

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Case Presentation

Case one

A 3 years plus 7-month-old male patient was referred to our unit in June 2019 due to cough and fever for 8 days and shortness of breath for 2 days. He had received 5 -days of intravenous Ceftazidime in the last hospital with no improvement. Instead, he developed shortness of breath and dyspnea. On admission, the physical examination showed that the body temperature was 38.2°C, pulse rate was 152 beats/min, respiratory rate (RR) was 56 breaths/min, and oxygen saturation was 90% on room air with an acute toxic appearance. He was noted as tachypneic with intercostal and supraclavicular retractions.

On auscultation, breath sounds were diminished in his right lung area, but no moist rales were heard. Other system examinations were unremarkable. Blood investigation revealed a white blood cell count of 21.41 × 109/L (normal range: 4.0-10.0 × 109/L) with 78.6% Neutrophil, normal hemoglobin, and platelets, and elevated C-reactive protein (CRP, 95.25 mg/L, normal range: 0-5 mg/L). Liver and kidney function, coagulation function and basic electrolytes were unremarkable. Chest Computed Tomography (CT) taken at the last hospital revealed large consolidation in upper lobe of right lung with mild to moderate right pleural effusion or presumed empyema (Figure 1A). Arterial blood gas at admission showed a pH of 7.40, partial oxygen pressure (PO2) of 80 mmHg, and a calculated P/F (PO2/oxygen absorption concentration) value equal to 145.

He was initiated with intravenous ceftriaxone (10 0mg/kg, once a day) and vancomycin (15 mg/kg, q6h) as empirically antimicrobial therapy. Due to increasing work of breathing and low P/F ratio, he was intubated and given mechanical ventilation. Thoracocentesis was administered under ultrasound B guidance on the following day, draining out 20 ml of cloudy pleural effusion. The specimen for laboratory test revealed elevated white blood cell counts (1617 × 109 /L) constituted of 91.1% multinuclear cell, low glucose (0.16 mmol/L), and elevated protein(36.5 g/L), and Gram-positive cocci were seen in smear staining. Culture from tracheal aspirate and blood sample both grew up sensitive Streptococcus pneumoniae (SP). By the fifth day of hospitalization, his fever resolved along with a significantly improved general condition, and the ventilator was weaned off. Reviewed thorax CT showed a huge loculated pneumatocele in the primary consolidation area of the right lung (Figure

1B), warranting the diagnosis of NP. After 2 weeks of anti-infective therapy, he was discharged and prescribed oral amoxicillin clavulanate for an extra 7-day treatment at home. At the end of home therapy, the patient developed fever again and was re-admitted. A new chest CT showed the loculated cavity coalesced to a large tensive pneumatocele, protracting to the mediastinum (Figure 1C). A thoracic surgeon was consulted, who proposed to respect the affected lobe. Being afraid of the operative complications and the damage to lung function, his parents refused to take the operation, requiring a conservative regimen for him. Based on the last pathogen results, we administered cefuroxime (100 mg/kg daily in two divided doses) as an antimicrobial agent in combination with bronchoscopic lavaging (two times, 1-day interval). Five days later, his fever subsided and clinical symptoms improved significantly. The patient was discharged after continuing 7 days of consolidation treatment. An additional two weeks of fusidic acid was required as post-discharge treatment. He was asymptomatic after discharge, and physical activity was not restricted. The patient was reexamined three months later. The thoracic CT (Figure 1D) showed that the primary pneumatocele disappeared and was completely replaced by normal lung tissue.

Case two

A 7-year-old female girl presented to our department with cough and fever for nearly 20 days. She was first admitted to a local hospital and underwent a chest CT scan, which showed a dense consolidation area in the lower lobe of the left lung with moderate pleural effusion. Cefoperazone-sulbactam was empirically administered despite the pathogen investigation being undiscovered and closed chest drainage was performed the next day. Because the fever still persisted, she was transferred to our department.

On admission, the patient was conscious but visibly tired and lethargic. No retraction and dyspnea were noted except for a little tachypnea (RR 35 beats/min). Her left thoracic cage slightly collapsed with a trachea deviation to the left. Breath sound in the left lung was significantly reduced, but no rales were heard. Cardiac and abdominal examinations were unremarkable. Laboratory results revealed white blood cells of 15.97 × 109/L (neutrophil 75.2%), normal red blood cell and PLT counts, and elevated CRP (30.82 mg/L). Serological examination for pathogen and sputum culture had no positive findings. Thoracic CT revealed large dense consolidation with an air-fluid level suspecting abscess formation in the lower lobe of the left lung (Figure 2A).

After admission, the patient was started on intravenous ceftriaxone (100 mg/kg, once daily) as empirical anti-infective therapy. A thoracic surgeon was consulted and recommended the necrosed lobe be removed to eliminate the pathogen reservoir, but her family was unwilling to take the risk of anesthesia and thoracotomy procedure. We performed a therapeutic bronchoscopy procedure on the following day and observed large amount of green pus exuding from the dorsal bronchus of left lower lobe. Pseudomonas aeruginosa,

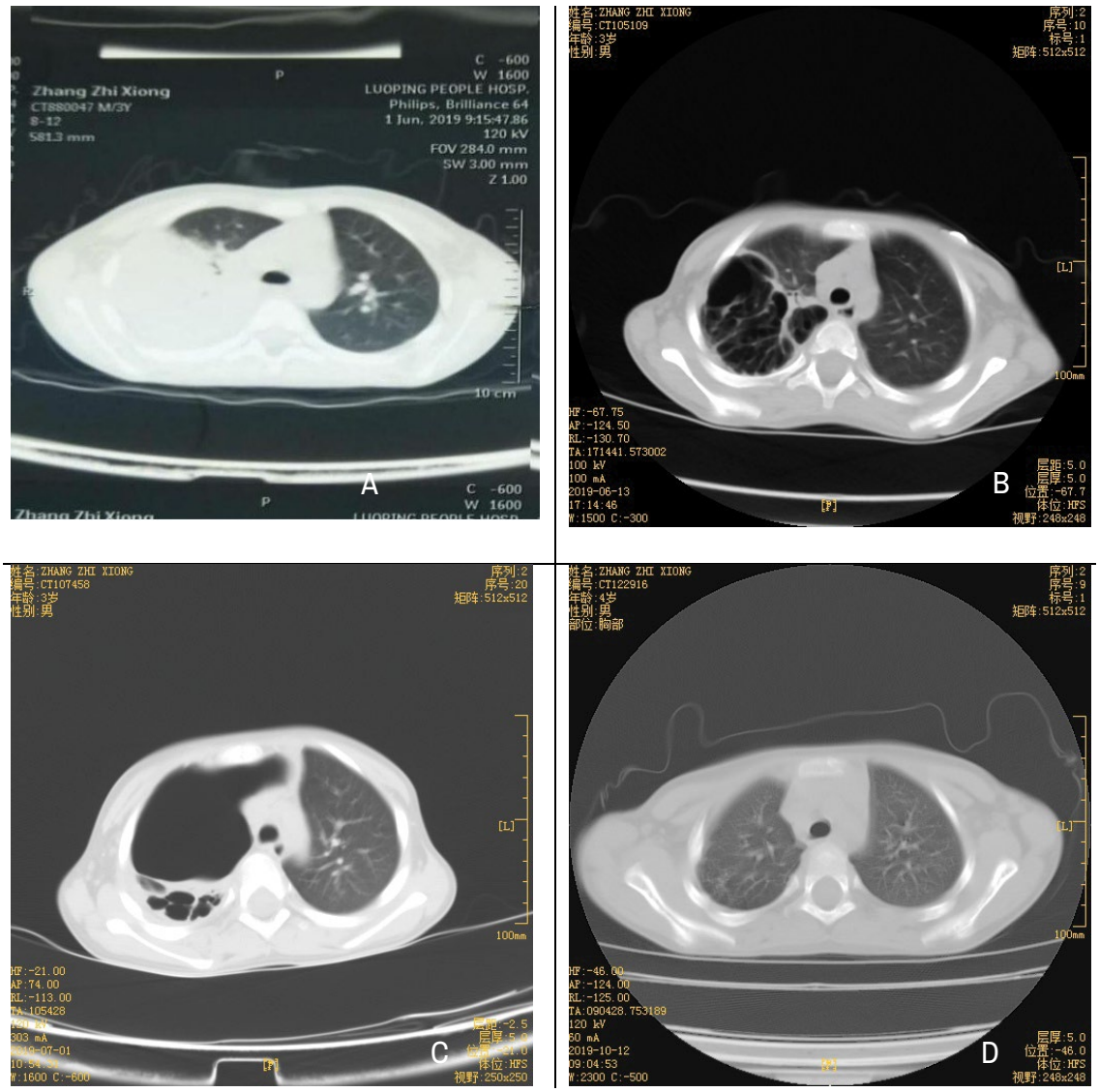

Figure 1. Evolution of chest CT without contrast in case one. (A) Large consolidation in the upper lobe of the right lung at the onset of disease. (B) Second thoracic CT after 12-day treatment showing an extended pneumatocele with multiple septum inside at almost the same section. (C) The third cheAst CT at two weeks interval showing a fused tensive pneumatocele protracted to mediastinum with thicken interlobular septum and patch shadow in the upper lobe of the right lung. (D) The fourth CT three months later showed primary pneumatocele had been totally replaced by normal lung tissue. (Note: Figure 1A was taken at another hospital and captured by cell phone).

which is resistant to β-lactam antibiotics but sensitive to imipenem, was cultured in the lavage fluid samples after fully lavaging. We then changed the current antibiotic to imipenem. After 10 days of imipenem treatment and two extra bronchoscopy lavaging (at an interval of 2 days), she had no recurrence of fever, and her main symptoms (cough and tachypnea) were markedly alleviated with a significantly improved mental status and appetite.

The patient was discharged after a hospital stay of three weeks and required to continue oral levofloxacin as post-discharge therapy for two weeks. The patient was re-examined 1 month later and was asymptomatic. The chest CT showed that the consolidation area and lumen were significantly reduced, and the air-liquid interface disappeared (Figure 2B). The chest CT of the patient at the 4-month follow-up showed that the consolidation segment and the lucent cavity disappeared, and the local pleura thickened with small ground-glass opacity (Figure 2C).

Discussion

NP is a pathological term characterized by massive exudation, extensive consolidation, and succeeding liquefaction in the pulmonary parenchyma. Its major causative factor is bacterial infection, which activates inflammatory damage and stimulates pulmonary vascular thrombogenesis and occlusion. Thus, it synergically leads to lung tissue devitalization and necrosis [9]. The diagnosis of NP depends on radiology, especially chest CT. NP can be diagnosed when single or multiple irregular lucency emerges in the consolidation area of chest CT. In this case report, both patients had large consolidation on their first thoracic CT. As the disease progresses, loculated pneumatocele or large cavitation was observed in primary consolidation areas on CT images, suggesting the appearance of lung necrosis.

The manifestations and severity of NP vary by pathogens. Streptococcus pneumoniae, regarded as the most frequently offending bacteria, is liable to cause respiratory failure, septic shock, and complications of thoracic cavity, while Gram-negative bacteria like Klebsiella usually generated evident poisoning symptoms accompanied by temperature fluctuations [10]. Mycoplasma pneumoniae infection typically results in prolonged febrile duration, severe less-productive cough, and delayed lung necrosis, usually occurring around 2 weeks into the disease course [11]. In case one, the patients presented severe dyspnea and respiratory failure (P/F ratio, 142), requiring mechanical ventilation to relieve respiratory distress and maintain oxygenation. Subsequent microbiological results confirmed an infection of Streptococcus pneumoniae. The second case exhibited very lethargy and loss of appetite with a distinct toxic appearance. Pseudomonas aeruginosa was identified in her BALF. The etiological findings of both patients were consistent with their clinical features.

Intravenous antibiotics administration was the mainstay treatment of NP.

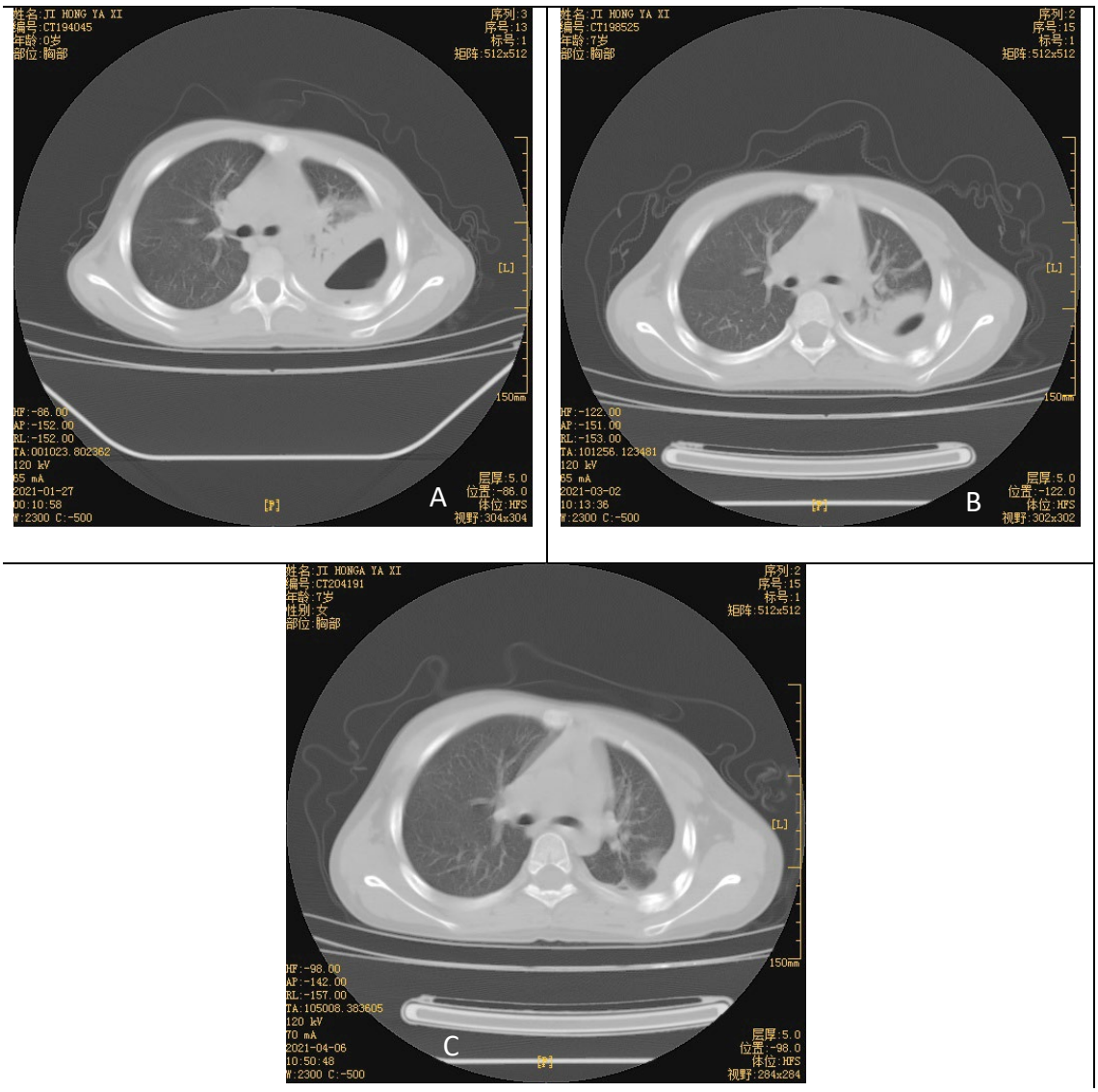

Figure 2. Chest CT evolution of case two. (A) The chest CT on admission showed vast dense consolidation containing an air-fluid level in the lower lobe of the left lung and left thoracic cage had slightly collapsed. (B) Repeated chest CT one month later showed the consolidation area and air cavitation inside were remarkably narrowed. (C) Follow-up CT at a one-month interval revealed the consolidation segment and lucent cavity had disappeared with local thickening pleura and a small ground glass shadow left.

Surgery is required when NP patients develop thoracic complications or did not respond, even deterioration to the antibiotics used [3,12]. Categories of aggressive surgical operation include debridement of necrotic areas, pulmonary decortication, cavity washing, or lobectomy via thoracotomy or thoracoscope, which are considered can remove the necrotic lung tissue, identify the pathogen and clear the pleural empyema, thereby resulting in significant clinical improvement and earlier recovery [3,4]. Many literatures encouraged aggressive surgical intervention. In a retrospective study by Lai JY, et al. [3], 56 patients with NP benefit from surgery (decortications or wedge/ lobectomy). Moreover, those having lobectomy had a shorter postoperative course than those with decortications and wedge resection. Refaely Y, et al. [13] suggested that the impaired pulmonary segment or lobe should be resected as early as possible, as delay in surgery is associated with progressive damage to lung parenchyma and higher complications rates [14].

In contrast, Gross I, et al. [15] reported 6 patients with NP complicated by giant lung cyst or lung abscess, all of whom showed complete clinical and radiographic resolution with appropriate antibiotic treatment. NP can be successfully treated with antibiotics and pleural drainage without major surgical intervention [16]. In most cases of NP, lobectomy or thoracotomy is unnecessary because inadequate surgical removal of necrotic tissue may lead to more severe outcomes. Reimel BA, et al. [17] reported 8 patients with NP who underwent surgical resection, three of whom died and two were chronically ventilated. Similarly, in Westphal FZ, et al's. study [5], 20 children who underwent surgical intervention had a mortality rate of up to 20%. Given that aggressive surgery may bring more harm than benefits, American Academy of Pediatric Surgery guidelines recommended that NP should be treated non-surgically [18].

Both cases in this report were refractory infections, caused by abscess formation or large pneumatocele, which were documented indications for surgery resection advocated in literature [3,12]. However, the two patients were not treated with surgery due to their parents' concerns about complications of thoracotomy and damage to lung function. Through conservative modalities including a lengthy course of antibiotics, bronchoscopy lavaging, thoracocentesis, and symptomatic treatment, the infections were finally well-controlled. Their radiologic abnormalities also resolved almost completely during a 4- to 5-month follow-up period. Our report adds more evidence for the effectiveness of conservative treatment of NP.

In conclusion, in most cases, NP can be completely resolved with a conservative treatment regimen base on clinical symptoms and radiological image evidence. Aggressive surgical management should be cautious even in patients with a recognized indication for surgery.

Conflict of Interest

None declared.

Author Contributions

YL and HMF, responsible for manuscript production, literature review, and image understanding. TYY and JWY, the primary attending doctor of the patient responsible for the care of the patient and follow-up work. HFL, PLL and FL, responsible for helping to make significant edits to the manuscript, and providing guidance for publication and literature review.

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