NECROTIZING PNEUMONIA IN INFANTS

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SUMMARY – Community-acquired bacterial pneumonias generally have a good prognosis, given a good response to the antibiotic treatment applied, and complications such as pleural effusion, empyema, abscess and necrotizing pneumonia with pneumatocele formation (cavitary necrosis) are rare. Although cavitary necrosis is manifested as a severe disease, most children show complete recovery even without surgical treatment and have normal chest radiographs at long term. A case is presented of an immunocompetent infant that developed necrotizing pneumonia with pneumatocele formation during treatment of bacterial pneumonia. Conservative treatment led to complete regression of necrotic cavities and resulted in normal chest radiography finding 2.5 months of the occurrence of pneumatoceles.

Key words:*Pneumonia – complications; Pneumonia – drug therapy; Community-acquired infections – complications; Necrosis – drug therapy; Infant; Case report*

Introduction

The community-acquired bacterial lobar pneumonia is a common infectious disease with a typically benign outcome[1]. Although the use of appropriate antibiotics has significantly reduced the number of complications arisen from bacterial pneumonias, severe complications such as cavitary necrosis, abscess formation, effusion or empyema are still encountered[2,3].

Cavitary necrosis or necrotizing pneumonia with pneumatocele formation is defined as a combined loss of normal pulmonary parenchyma and development of multiple thin-walled cavities filled with air or fluid[4]. Necrotic cavities are not often reported and most cases of necrotizing pneumonias reported so far refer to adults and were usually caused by *Staphylococcus aureus*. However, recently an increasing number of necrotizing pneumonia cases have been reported in children, often caused by *Streptococcus pneumoniae*[4-6].

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Necrotizing pneumonia is usually described as a complication of severe lobar or segmental pneumonia in children over one year of age, and in the necrotizing area a varying number of thin-walled cavities are found[5,6].

The presence of necrotizing cavities in complicated pneumonias in children is not an absolute indication for surgical intervention[2,6-8]. Bronchopleural fistulas and multilocalized empyema are indications for surgical intervention, whereas patients with small cavities and localized effusions respond well to conservative treatment[4].

Therefore, unlike adults, children usually recover without surgical intervention and at long term their radiographic finding is normal without pulmonary sequels[9].

Case Report

We describe an eight-month female infant, healthy before the current disease, duly vaccinated including the pneumococcal conjugate vaccine. There was no contact with tuberculosis, and family history was negative for immune, respiratory or hereditary diseases.

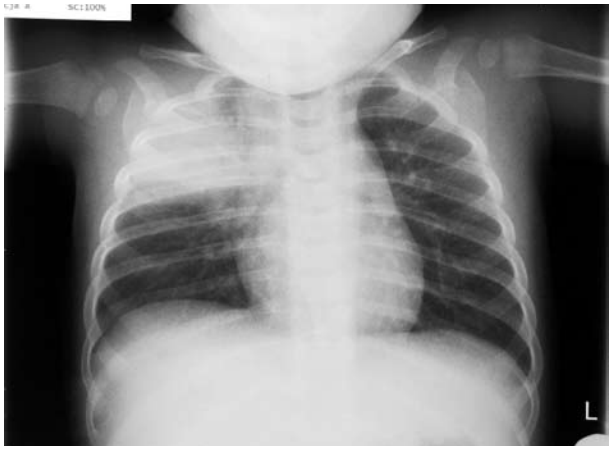

Fig. 1. Radiograph upon admission shows the almost entirely shadowed right upper lung lobe.

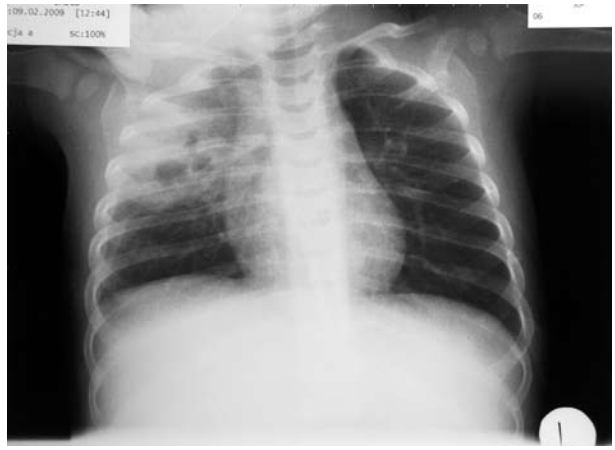

Fig. 2. On day 5 of hospital stay, radiograph still shows an extensive infiltrate in the right upper lobe with several transparent zones within the consolidation area.

The disease manifested with three-day temperature, fatigue and poor oral intake. Three days before admission, oral amoxicillin therapy was started. On the day of admission, the infant began to cough, breathe heavily and moan. On admission, the child was conscious, exhausted, sickly in appearance, dyspneic and moaning. Physical findings: pulse 160/min, respiration 50/min, body temperature 39.4 °C, and O_2 saturation in room air 94%. Attenuated breath sounds distally on the right in the scapular region, on breathing using accessory muscles of breathing. Chest radiography showed an almost entirely shadowed right upper lung lobe, limited by the horizontal interlobe; the finding corresponded to extensive pneumonia of the right upper lung lobe without signs of pleural effusion (Fig. 1).

Laboratory findings: acid-base status pH 7.47; pCO_2 3.3 kPa; BE -4.0 mmol/L; O_2 saturation 94%; leukocytes 19.0x10^9/L, of which segmented granulocytes 46%, non-segmented granulocytes 29%, lymphocytes 20% and monocytes 5%; hemoglobin 99 g/L; platelets 279x10^9/L; erythrocyte sedimentation rate (ESR) 76 mm, and C-reactive protein (CRP) 355.1 mg/L.

Based on the auscultation finding and consolidation shown on the radiograph, lobar pneumonia was diagnosed. After obtaining blood cultures, nasopharyngeal and pharyngeal swabs, intravenous ceftriaxone therapy at a dosage of 100 mg/kg/day was introduced.

After five days of therapy, high febrility persisted, with extreme exhaustion and sickly appearance, high CRP (200 mg/L) and 13% of non-segmented granulocytes. Therefore, follow-up chest radiography was performed, on which an extensive infiltrate of the right upper lobe of the lung was still visible, without signs of regression, but with several transparent zones within the consolidation area (Fig. 2).

The pulmonary cavities seen on chest radiograph confirmed the diagnosis of necrotizing pneumonia. Due to the developing necrotizing pneumonia with pneumatoceles and the suspected pneumonia caused by *Staphylococcus aureus*, on day 5 antibiotic therapy was changed and the patient began to receive cefazolin at a dosage of 75 mg/kg/day. Two days after therapy modification, the child became afebrile. Cefazolin therapy was administered for two weeks to be succeeded by oral cefixime therapy for another week.

Blood cultures were negative, physiological flora was found in the pharyngeal swab, and *Streptococcus pneumoniae* was isolated from the nasopharyngeal swab.

PPD (5 TU) was non-reactive; cultures of gastric lavage and blood for *Mycobacterium tuberculosis* were performed to exclude tuberculous process and were found to be negative.

Immunoglubulin levels were normal, antistaphylolysin antibodies negative, and antistreptolysin O level was normal (10.0 IU/mL).

Subsequently, during therapy administration, CRP levels declined: 88.2 mg/L (day 6), 30.6 mg/L (day 8) and 5.9 mg/L (day 12). After 20 days of hospital stay, CRP level remained at 1.2 mg/L, and before

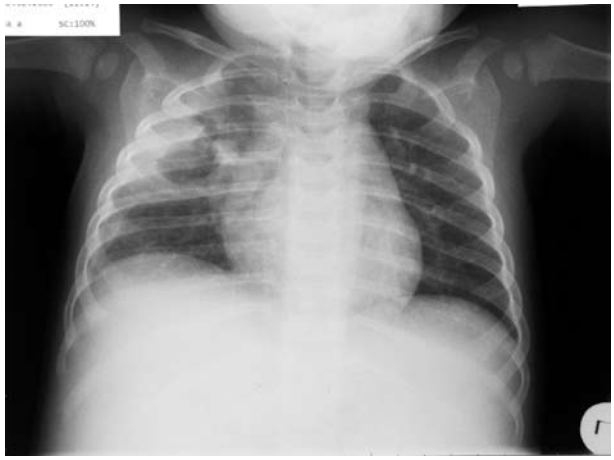

Fig. 3. Follow-up radiograph on day 8 of hospital stay shows regression of the infiltrate with a central transparency zone.

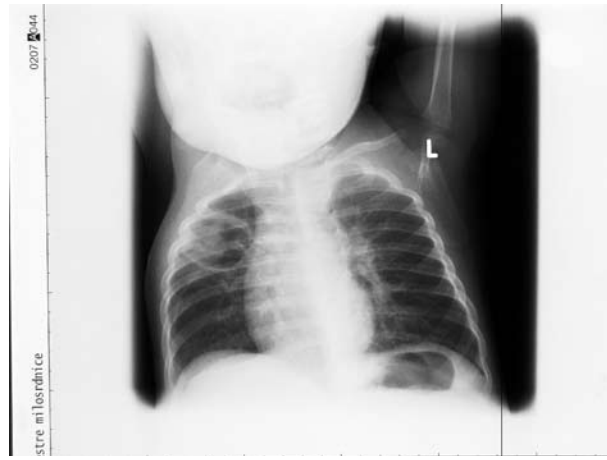

Fig. 4. Radiograph taken on day 19 of treatment initiation shows regression of the lung infiltrate with large oval destruction of the pulmonary parenchyma.

discharge ESR was 11 mm and leukocytes 8.4x10^9/L, with normal differential blood count.

Follow-up chest radiography taken on day 8 of hospital stay showed regression of pneumonic infiltration with visible extensive transparency in the central part, corresponding to destruction of pulmonary parenchyma. Less shadowed was the right phrenicocostal sinus in terms of lesser effusion (Fig. 3). Chest radiography taken on day 19 showed complete regression of the lung infiltrate with a large 3-cm oval destruction of the pulmonary parenchyma (Fig. 4).

After 25 days of hospital stay, the child was discharged for home care in good general condition. Follow-up chest radiograph taken 2.5 months after the occurrence of pneumatoceles was normal (Fig. 5).

Discussion

Although the progression of bacterial pneumonias today is in most cases benign and responds well to conservative antibiotic treatment, complications may still occur, such as pleural effusion, empyema, pulmonary abscess or necrotizing pneumonia[10,11]. Complicated pneumonias are mostly caused by pathogenic bacteria such as *Staphylococcus aureus* or *Streptococcus pneumoniae*, although in 45%-89% of cases the cultures are negative[10,11]. Complications are also reported, albeit much more rarely, with pneumonias caused by many other bacteria (*Haemophilus influenzae, Escherichia coli, Klebsiella pneumoniae,* Group A *Streptococcus*), as well as *Mycoplasma pneumoniae* and adenoviruses[1,12].

An increase has recently been recorded in necrotizing pneumonias as pneumonia complications in children's population, with *Streptococcus pneumoniae* being the predominant cause, but without clear explanation[5,13,14]. Pneumococcus serotype 1 causes significantly more frequent complications, which are also described in association with serotypes 3 and 14[10]. The reason behind such an increase in complications is unknown, just as it is unknown whether the cause lies in the host, the environment, or should be sought among the causative microbial factors[15,16].

According to a study, from 1997 to 2000, 13% of pneumonias caused by pneumococcus were associated with destructive lesions of the pulmonary parenchy-

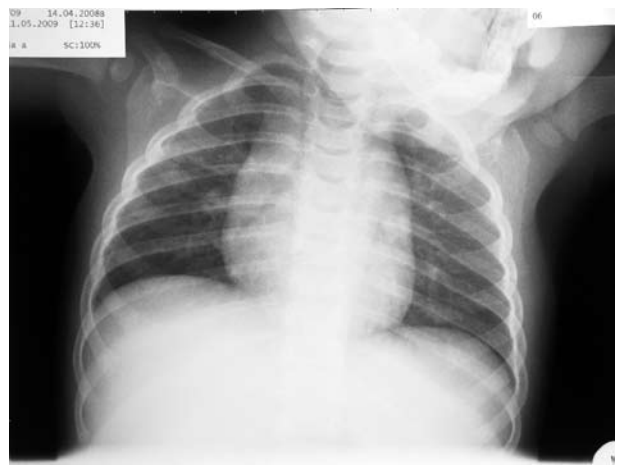

Fig. 5. Normal chest radiography finding 2.5 months of the occurrence of pneumatoceles.

ma, and from 2001 to 2006 as much as 33% of pneumococcal pneumonias were complicated by necrosis[17]. This should certainly in part be ascribed to the improved identification of necrotizing pneumonias owing to computerized tomography (CT)[11].

The reason why this necrosis mechanism occurs only in a small number of patients with bacterial pneumonias is still unclear. In adult patients, necrosis and pulmonary cavitation may be caused by mixed flora with anaerobic bacteria involved in the necrotic process[18]. However, such cases are not described in children, where the common causes are *Staphylococcus aureus* or pneumococcus[13,18].

Necrotizing pneumonia is characterized by consolidated pulmonary tissue necrosis. Depending on the severity and distribution, necrotizing pneumonia may be combined with solitary or multiple or multilocular radiolucent areas, bronchopleural fistulas and intrapulmonary abscesses, largely in one, and more rarely in several lobes[19,20]. The spread of necrosis toward the pleura leads to the formation of a bronchopleural fistula.

It is believed that the mechanism of necrosis development in complicated pneumonias involves thrombotic occlusion of alveolar capillaries in the areas of consolidation which, combined with inflammation, leads to the ischemia and necrosis of the devitalized pulmonary parenchyma[2,6,21].

Pneumatoceles are intraparenchymal, thin walled, air-filled cysts developing secondarily in the areas of bronchiolar and alveolar necrosis, and from them air can pass only into the interstitial space[22]. They occur in 2%-8% of hospitalized children with pneumonia[10]. They often occur in immunocompetent patients as well[20]. Mechanically ventilated patients run a higher risk of developing pneumatoceles, including their increased size and the development of tension pneumatoceles[23].

Here we present a case of community-acquired pneumonia complicated by the development of necrotizing pneumonia with pneumatoceles in an immunocompetent, previously healthy 8-month female infant.

High temperature, leukocytosis, markedly high CRP and ESR, and lobar consolidation on the chest radiograph of our patient spoke in favor of bacterial pneumonia. However, we could not identify the pneumonia agent in the patient. It is known that agent identification without thoracocentesis and pleural fluid culture may be quite difficult, especially if preceded by the administration of antibiotic therapy, as in our patient. Blood culture tests were negative, while the finding of *Streptococcus pneumoniae* in nasopharyngeal swab did not necessarily point to it as the causative agent, the more so as the patient had received the pneumococcal conjugate vaccine.

Considering the fact that the infant was highly febrile, sickly in appearance, and with high inflammatory parameters still on day 5 of the introduction of antibiotic therapy, complications were suspected and it was the reason for radiological reevaluation. Follow-up chest radiography indicated necrotizing pneumonia with destruction of the pulmonary parenchyma in the form of multiple radiolucencies within the consolidation area. Due to the suspected pneumonia caused by *Staphylococcus aureus*, antibiotic therapy was changed. We decided to change the hitherto administered ceftriaxone therapy, i.e. the third generation cephalosporin, to the first generation cephalosporin, cefazolin, because the first generation cephalosporins have an antimicrobial effect on most agents causing necrotizing pneumonia in children (gram-positive cocci, most *Escherichia coli* strains, *Klebsiella pneumoniae*) as well as on methicillin-resistant, coagulase-positive or -negative staphylococci, on which the third generation cephalosporins have no effect.

Children with pneumonia complications usually look severely ill, with arterial desaturation and recurrent anemia and thrombocytosis, and toxic appearance and temperature persisting for even up to 23 days are reported in patients with necrotizing pneumonias[5,24]. Progressive necrosis explains well the ongoing febrile condition with a poor response to antibiotic therapy, as also in our patient.

It is believed that high CRP and the presence of immature polymorphonuclears at the periphery are important precursors of necrosis, i.e. destruction of pulmonary tissue[25]. Our infant had high inflammatory parameters and leukocytosis with 26% of immature polymorphonuclears. The patient was hospitalized for 25 days; according to the studies available, hospitalization for pneumonias with complications lasts for 15-35 days on an average[24]. During hospital stay, the patient was continuously monitored for possible com-

plication risks, primarily pneumothorax. All children with necrotizing cavities require close surveillance and monitoring[6,9,10]. Complete resolution of pneumatoceles on the radiograph of our infant ensued 10 weeks after their occurrence; after all, their resolution is usually described after more than 40 weeks of their occurrence[9].

It is known that most pneumatoceles (over 85%) resolve spontaneously, partially or completely for weeks or months without radiological sequels[6,26]. On the other hand, air pressure increase in the pneumatocele leads to its distension and gives rise to the so-called tension pneumatocele that with its compression may compromise the cardiorespiratory function. Another complication caused by tension pneumatocele is rupture into the pleural space causing the development of pneumothorax or bronchopleural fistula. Pneumatoceles may also complicate through a secondary infection[27]. Lobectomy is recommended for patients with multiple tension pneumatoceles[27].

Necrotizing cavities can be seen on a radiograph and CT image[5,6,28]. Necrotizing cavities as a pneumonia complication are often seen on CT rather than radiograph. Visibility on the radiograph depends on the cavity content, and the air-filled cavities are more visible than the fluid-filled ones[9]. It can be explained by the fact that the fluid-filled cavities are of the same density as the consolidated pulmonary tissue, which makes them more difficult to identify on the radiograph[9]. Computed tomography is therefore superior to radiography when it comes to showing cavitary necroses as pneumonia complications, as well as showing other parenchymal and pleural complications; besides, it plays a crucial role in determining the need for surgical intervention[4]. Considering the presentation of necrotic cavities on the radiograph of our infant as early as on day 5 of hospitalization and further on their careful monitoring and regression on the radiograph, there was no indication for CT.

Empyema, often associated with necrotizing pneumonias in adults, is relatively rare in children affected by bacterial pneumonias. This is because children, compared with adults, have a greater capacity to reabsorb the inflammatory pleura products, so in children, unlike adults, less invasive treatment methods, such as decortication, are recommended[8,29].

The case presented confirms previous experience suggesting that conservative treatment of children with severe bacterial pneumonias accompanied by extensive necroses of pulmonary parenchyma usually leads to complete regression of necrotic cavities. Consequently, unlike adults, invasive surgical procedures are rarely required in children[9,24,29].

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Sažetak

NEKROTIZIRAJUĆA PNEUMONIJA U DOJENČADI

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Izvanbolničke bakterijske pneumonije uglavnom imaju dobru prognozu, uz dobar odgovor na primijenjeno antibiotsko liječenje, te se rijetko razviju komplikacije kao što su pleuralni izljev (efuzije), empijem, apsces i nekrotizirajuća pneumonija s razvojem pneumatocela (kavitarna nekroza). Premda se kavitarna nekroza manifestira teškom bolešću, većina djece se potpuno oporavi i bez kirurškog liječenja, te nakon duljeg vremena imaju uredan izgled pluća na rentgenskoj snimci. Ovdje se prikazuje slučaj imunokompetentnog dojenčeta kod kojega je tijekom liječenja bakterijske pneumonije nastupila nekrotizirajuća pneumonija s razvojem pneumatocela. Konzervativno liječenje dovelo je do potpune regresije nekrotičnih šupljina i urednog rentgenskog nalaza pluća 2,5 mjeseca nakon pojave pneumatocela.

Ključne riječi: *Pneumonija – komplikacije; Pneumonija – terapija lijekovima; Infekcije stečene u zajednici – komplikacije; Nekroza – terapija lijekovima; Dojenče; Prikaz slučaja*