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Evaluation of the Outcomes of Conservative or Minimally Invasive Treatment Measures in Pediatric Pleural Empyemas

[1]Recep Sancak, [1]Sukru Paksu, [1]Ozgur Sakarya and [2]Rıza Rızalar

[1]Ondokuz Mayıs University, Faculty of Medicine, Department of Pediatrics, 55139 Samsun, Turkey
[2]Ondokuz Mayıs University, Faculty of Medicine, Department of Pediatric Surgery, 55139, Samsun, Turkey

Abstract: The purpose of this study was to evaluate the treatment measures applied in patients treated with the diagnosis of pleural empyema in our clinic within 10 years and to discuss their outcomes. Cases treated between January 1995 and December 2005 were evaluated retrospectively. Age, sex, the symptoms and their durations, treatments prior to admission to our clinic, predisposing factors, clinical signs, hematological parameters and acute phase reactants, characteristics of the pleural fluid, therapeutic approaches, duration of hospitalization, and prognosis were the parameters of evaluation. One hundred and forty-seven patients consisting of 91 (61.9%) males and 56 (38.1%) females were included in the study. The average durations between the onset of sympthoms and admission to hospital was 9.8±6.5 (range; 2-15) days. Eighty-three (56.4%) patients had previously been hospitalized and received parenteral antibiotic treatment in various clinics for an average of 6.0±3.9 (range; 1-16) days. Bacteria have been isolated in the pleural fluid cultures in 26 (17.7%) and in blood cultures in 10 (6.8%) cases. Ninety-three (63.2%) patients underwent closed underwater drainage via placement of chest tubes, whereas repetitive drainage thoracentesis was performed in 4 (2.7%) cases. The rest of the patients received antibiotic treatment alone. The average length of hospitalization was 20.7±9.0 (range; 7-58) days. 12 (8.1%) patients developed complications during follow-up, and of those, 4 (2.7%) patients were deceased.

Key words: Pleural empyema · Child · Treatment · Chest tube · Thoracentesis

INTRODUCTION

Empyema is the inflammation of the pleural membranes leading to accumulation of purulent material within the pleural space. It usually develops as a complication of bacterial pneumonia [1, 2]. In its acute stage, it causes severe respiratory problems, warranting prolonged hospitalization. Even after its acute phase is resolved, it is still likely to cause complications such as pleural adhesions and thickening in the late period. These features make empyema an important health problem in the pediatric age group. The introduction of wide-spectrum antibiotics has increased the success rates of treatment, and reduced the frequency of complications and mortality rates [3, 4]. Despite variations in therapeutic approaches between clinics, the main objectives of treatment are similar: to control the underlying infection, evacuate the purulent material, and re-expand the lungs [2]. In the pediatric age group, appropriate antibiotic treatment and sufficient fluid drainage usually provides complete resolution of empyemas [5]. In this study, we have retrospectively investigated the cases of pleural empyema who had antibiotic treatment, with or without chest tube drainage.

MATERIALS AND METHODS

Patients who were admitted to and followed up in the Pediatric Infectious Diseases Department of Ondokuz Mayıs University Faculty of Medicine between January 1995 and December 2005 with the diagnosis of pleural empyema were retrospectively investigated. Neonates, effusions due to causes other than infections, and cases with tuberculosis were excluded. A detailed history including the disease onset, emergence of symptoms, hospitalization in other clinics prior to admission to our hospital, and the treatments having been administered was gathered, and physical examination sheet was reviewed for each patient file, along with routine laboratory test results including chest X-rays and thoracic ultrasonography (USG), complete blood counts, erythrocyte sedimentation rates, C-reactive protein levels

Corresponding Author: Dr. Recep Sancak, Ondokuz Mayıs University, Faculty of Medicine, Department of Pediatrics, 55139 Samsun, Turkey

and blood cultures. On admission, each patient had undergone diagnostic thoracentesis, and the pleural fluid drawn was tested for glucose, lactate dehydrogenase (LDH), and protein levels. Also, microbiologic investigations including aerobic cultures and Gram staining were performed in the pleural fluid specimens. Radiological demonstration of pleural fluid in a patient with clinical signs of pneumonia and the presence of one of the following characteristics in the fluid were regarded as the diagnostic criteria for pleural empyema; (i) leukocyte counts exceeding 1000/mm^3, (ii) protein levels over 3 g/dL, (iii) glucose levels under 20 mg/dL, (iv) LDH levels over 1000 IU/L, and (v) direct visualization of microorganisms with Gram staining or isolation of bacteria in cultures. The parameters of evaluation were age, sex, the symptoms and their durations, treatments received prior to admission to our clinic, predisposing factors, clinical findings, hematological parameters and acute phase reactants, the characteristics of pleural fluid, therapeutic approaches, duration of hospitalization, and prognosis.

RESULTS

A total of 147 patients diagnosed with empyema within the study period were evaluated. Of the patients, 91 (61.9%) were males, and 56 (38.1%) were females, with a mean age of 3.8±3.5 years (range; 1 months-15 years). The mean duration between the onset of symptoms and admission to hospital was 9.8±6.5 (range; 2-15) days. Eighty-three (56.4%) patients had been hospitalized prior to admission to our clinic for 1 to 16 days and received parenteral antibiotic treatment. The most common presenting symptoms of cases on admission and the findings of physical examination are summarized in Table 1 and 2.

The empyemas were found to have involved the right, left, and both lungs in 78 (53.1%), 64 (43.5%) and 5 (3.4%) of the cases, respectively. Microorganisms were observed with Gram staining of the pleural fluid in 48 (32.7%) cases. Bacteria were isolated in the cultures of pleural fluid and blood in 26 (17.7%) and 10 (6.8%) of the patients, respectively (Table 3 and 4).

Leukocytosis was found to be present on admission in 100 (68%) of the total 147 patients. In 54 (54%) of these, the leukocyte count exceeded 20,000/mm^3. Leukopenia was found on admission in 2 (1.4%) cases. The hemoglobin level was lower than 10 g/dL in 99 (61.3%) patients. Among these, 23 (23.2%) had hemoglobin levels below 7 g/dL, while 3 (3.0%) had levels below 5 g/dL. Thrombocytopenia (thrombocyte count below 150,000/mm^3) and thrombocytosis (thrombocyte count above 450,000/mm^3) were found in 8 (5.4%) and 78 (53.0%) of the patients, respectively.

Wide-spectrum antibiotic treatment was found to be initiated in all patients upon hospitalization and continued intravenously during hospital stay. Chest tubes were placed for closed underwater drainage in 93 (63.2%) patients, whereas 4 (2.7%) patients underwent repetitive drainage thoracentesis. The rest of the patients received no invasive procedure other than diagnostic thoracentesis. The mean duration of drainage in cases with closed underwater drainage was 12.7±6.6 (range; 3-35) days.

Table 1: The complaints of patients on admission

Complaint	n	Percent
Fever	133	90.5
Cough	114	77.6
respiratory distress	76	51.7
Vomiting	37	25.2
Weakness	34	23.1
Chest pain and/or abdominal pain	29	19.7
Anorexia	28	19.0

Table 2: The physical examination findings of patients on admission

Finding	n	Percent
Breath sound decrease or absent	133	90.5
Abnormal breath sound)	123	83.7
Tachypnea	95	64.6
Fever	81	55.1
tachycardia	69	46.9
hepatomegaly	66	44.9
Retraction	50	34.0
Nose breathing	34	23.1
Hipotansiyon and cardiovascular failure	11	7.7
Concious alteration	10	6.8
Cyanosis	9	6.1

Table 3: The microorganisms isolated in the pleural fluid cultures

Microorganism	n=26
Staphylococcus aureus	12
Coagulase negative staphylococci	5
Streptococcus pneumoniae	6
Enterobacter spp	2
Haemophilus influenzae	1

Table 4: The microorganisms isolated in the blood cultures

Microorganism	n=10
Streptococcus pneumoniae	5
Staphylococcus aureus	3
Coagulase negative staphylococci	2

The mean duration of hospitalization was found to be 20.7±9.0 (range; 7-58) days, and was significantly longer in the cases with chest tube placement (22.6±9.4 days) than those without (16.6±7.4 days) ($p<0.05$). One hundred and forty-three (97.3%) patients were discharged with complete recovery, while 4 (2.7%) died. Complications developed in 12 (8.1%) of the patients (pneumothorax in 9, and pneumothorax and bronchopleural fistulas in 3) during follow-up. One of these complicated patients died while the rest were discharged with complete recovery.

DISCUSSION

Accumulation of fluid within the pleural space due to pneumonia is called parapneumonic pleural effusion, whereas this fluid is called pleural empyema if it has purulent characteristics. Despite developments in diagnostic and therapeutic methods, pleural empyema still remains as an important cause of morbidity in children [6, 7].

Most of the cases with pleural empyema lack a predisposing factor, and empyema develops as a complication of bacterial pneumonia. In our study, predisposing factors were found in 10 (6.8%) patients (malnutrition in 5, mental retardation and epilepsy in 2, viral hepatitis in 1, chickenpox in 1, and common variable immune deficiency in 1 patient). Pleural empyema had developed as a complication of community-based pneumonia in other patients.

The mean duration between onset of complaints and admission to our hospital was 9.8±6.5 (range; 2-15) days, and 83 (56.5%) of the patients had received intravenous antibiotic treatment in other clinics for a mean duration of 6.0±3.9 (range; 1-16) days. These results, being close to those reported in previous publications in the literature, reflect that a significant proportion of the patients with pleural empyema receive late diagnosis and/or insufficient treatment [8-10].

Despite the presence of studies in which the duration of hospitalization was reported to be shorter in the literature, we have found the mean duration of hospitalization in our study to be 20.7±9.0 (range; 7-58) days. This duration is consistent with those reported in some previous studies in which the conservative therapeutic approaches were evaluated [9, 11]. In addition, the mean duration of hospitalization was found to be significantly longer in patients who had a chest tube introduced. This was attributed to the greater amount of pleural fluid and more severe clinical outlook which warranted a chest-tube to be placed.

The mean duration of drainage in cases with closed underwater drainage was 12.7±6.6 (range; 3-35) days, and was consistent with those reported in previous studies [9, 10, 12, 13].

The rate of isolation of bacteria in blood and pleural fluids is highly variable in the literature, being reported between 8-76% [14-17]. This situation is probably due to the initiation of antibiotic treatment in patients before cultures are gathered. Introduction of molecular techniques such as PCR increases the chance of pinpointing the pathogenic agents, particularly in patients who had received antibiotic treatment beforehand [18]. In our study, the rate of isolation of microorganisms was found to be 17.6% in pleural fluid cultures, and 6.8% in blood cultures. Gram (+) cocci was directly visualized with gram staining of the pleural fluids in 22 patients, in the cultures of whom microorganisms could not be isolated. The fact that 18 of the 26 cases in which the causative agent had been successfully identified in the pleural fluid cultures had not received parenteral antibiotic treatment beforehand supports the hypothesis that initiation of antibiotic treatment reduces the chance of isolating microorganisms in cultures.

While pneumococci are more frequently isolated in developed countries as pathogenic agents, the most common cause of empyema in developing countries is *S. aureus* [5, 9, 19, 20]. Therefore, the initial treatment of pleural empyema developing secondary to pneumonia in a previously healthy child should cover the agents of community-based pneumonia, particularly *S. pneumoniae* and *S. aureus*. An anti-anaerobic agent can also be included in the treatment regimen in the cases bearing the possibility of anaerobic infections; a history of aspiration or cerebral palsy can be suggestive [5]. In the pleural fluids of our patients, we have most frequently isolated *S. aureus*. This finding is consistent with those found in previous studies [9, 19, 11,12, 21, 22].

The initial blood count of the patients usually displays anemia, leukocytosis and thrombocytosis, while the serum acute phase reactants are increased [5]. In our patients, 68% had leukocytosis, 61% had anemia, and 53% had thrombocytosis. Leukopenia was found in 2 (1.4%) and thrombocytopenia was found in 8 (5.4%) of the patients.

The treatment of empyema includes controlling the infection, evacuation of the pleural fluid, and restoration and maintenance of normal pulmonary functions. Details of the treatment seem to vary between individual centers; however, administration of appropriate antibiotics and provision of sufficient fluid drainage usually results with

complete resolution of (veya recovery *from* – MSE) the empyema in children [5, 9]. The objectives of ideal treatment are reduced hospital stay, decreased likelihood of scarring due to invasive intervention, and long-term maintenance of normal pulmonary functions. The therapeutic options are antibiotic treatment alone or antibiotic treatment coupled with thoracentesis, chest tube placement, fibrinolytic treatment and drainage, open decortication or video-aided thoracoscopic surgery [5].

Usually, if the pleural effusion is minimal, antibiotic treatment is initiated and the patient is followed up. In case the effusion is excessive, a diagnostic thoracentesis is performed. If the pleural fluid is exudative, a chest tube is placed. In cases in which fluid drainage is insufficient due to localization, thoracostomy, fibrinolytic treatment, dissection of the adhesions using thoracoscopy, and debridement of the pleural space may be required. Thoracotomy and decortication may be performed in patients irresponsive to these measures. Instead of drainage with a chest tube, repetitive USG-aided drainages may be employed [23]. However, early drainage with a chest tube is more commonly recommended in order to obviate repetitive traumas [5].

In our study, 50 (34.0%) of our patients with low pleural fluid volume assessed with USG had been followed up with antibiotic treatment alone, whereas 93 (63.2%) had undergone closed underwater drainage with chest tubes in addition to antibiotic treatment and 4 (2.7%) had undergone repetitive drainage thoracenteses. While 132 (89.8%) of the patients had been discharged with complete recovery without development of any complications, complications had arisen in 12 (8.1%) cases (pneumothorax in 9, and pneumothorax and bronchopleural fistulas in 3). One of the patients, in whom bronchopleural fistula had developed, was deceased, while other complicated cases were discharged with complete recovery.

When compared with that of the adults, the mortality rate of pleural empyema in children is significantly lower [24], and is reported to be 0-2.9% in recent studies [9, 11, 20]. The mortality rate in our study was found to be 2.7%, which was similar to that of Caksen *et al.* [18]. Two of the 4 deceased cases already had borne requirement for mechanical ventilation upon admission, while one of the other two died of accompanying myocarditis and the fourth deceased case died of pneumothorax accompanied by bronchopleural fistula.

Satish *et al.* [25] have reported that surgical treatment was not required in any of their patients who underwent chest tube drainage and antibiotic treatment, and all of their patients recovered completely in the long term. Likewise, Chan *et al.* [26] have expressed that retrospective evaluation of 54 cases with empyema revealed successful treatment in only 7 patients with antibiotics alone, while 21 of the 47 patients who underwent chest tube drainage in addition to antibiotic treatment also required additional surgical operations. In our series, 9 (6.1%) of our patients had undergone decortication due to pleural thickening, 4 (2.7%) patients had undergone fibrinolytic therapy, and 1 (0.6%) patient had required thoracotomy for dissection of the adhesions, while others had successfully been treated with antibiotics alone or with antibiotics and chest tube drainage.

Despite the improvements in diagnostic and therapeutic measures, pleural empyema still remains to be one of the important causes of morbidity in children. Due to the paucity of controlled clinical studies, the optimal therapeutic measure is still a matter of contraversy. Although undertaken in a third-step medical center, in which more complicated cases are admitted, the results of our study suggest that pediatric pleural empyemas can successfully be treated with appropriate antibiotics and chest tube drainage. In addition, studies in which long-term respiratory function tests were evaluated following pleural empyema indicated that the pulmonary functions were well preserved in the long term in patients who received antibiotic treatment alone or antibiotic treatment accompanied by chest tube drainage [21, 25, 27, 28]. Being consistent with the results of similar studies in the literature, our results indicate that the most important drawback of conservative therapy is prolonged duration of hospitalization.

In conclusion, it appears that conservative therapy methods should still be considered with priority in the treatment of pediatric pleural effusion cases, particularly in developing countries.

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