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Early decortication in the treatment of pleural empyema in childhood: Indications and results*

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Özet

Çocuklarda ampiyem tedavisinde erken dekortikasyon: Endikasyon ve sonuçlar

Ampiyemli çocukların önemli bir kısmı antibiyotik ve plevral drenaj tedavisine yanıt verse de, bir kısmında bu tedavi ile başarı sağlanamaz. Çalışmamızda 5 yılda ampiyemli 57 çocuk hasta ile bunların içinde organize ve semptomatik ampiyem nedeniyle akciğer dekortikasyonu endikasyonu konmuş 21 çocuk hasta incelenmiştir. Dekortikasyon grubundaki olgularımızda streptokoklar (9 hasta) ve stafilokoklar (5 hasta) en sık üretilen mikroorganizmalardır. Dekortikasyon endikasyonlarımız; artan plevral kalınlaşma ve akciğer genişlemesinin en az % 50 kısıtlanması (tüm olgularda), inatçı ateş (13 olguda), akciğerden hava kaçağı (5 olguda), solunum sıkıntısı (5 olguda) ve 3 olguda parankimal infiltrasyonun artmasıdır. Plevral sıvının pH ve glikoz düzeyinin düşük, LDH ve protein düzeylerinin yüksek (>5 mg/dl), akciğer sıkışma oranının % 30'un üzerinde olmasının dekortikasyon için ön-belirleyici faktörler olduğu görülmüştür. Ameliyatlarda viseral ve pariyetal plevra tam olarak soyulmuştur. Dekortikasyonun ardından klinik ve radyolojik düzelme çok belirgin ve hızlı olarak gerçekleşmiştir. Ameliyat sonrası komplikasyon ve ölüm görülmemiştir. Erken dekortikasyonun çocuklardaki organize ve komplikasyonlu ampiyemlerde güvenilir ve etkin bir yöntem olduğu sonucuna varılmıştır.

Anahtar kelimeler: *Çocukluk çağı, ampiyem, erken dekortikasyon*

Summary

Although most childhood empyema respond to antibotics and pleural drainage, a recognizable number of children fail to improve after this treatment. This study reviews our experience with 57 children with empyema of which 21 have been selected for lung decortication due to an organizing and symptomatic disease over the past 5 years. In the children treated with decortication, pneumococcal (in nine children) and staphylococcal (in five children) infections were the most common positive bacteriological identifications. Indications for decortication were pleural thickening without resolution and at least a 50 % limitation of lung expansion (21), persistent fever (13), pulmonary air leakage (5), respiratory distress (5), and progression of parenchymal infiltrates (3). Factors determined to be predictors for decortication include low pleural fluid pH and glucose, high LDH (>1000 IU) and protein levels (>5 mg/dl), and lung compression ratio over 30 %. At operation, the visceral and parietal pleural peel was completely removed in each case. The clinical and radiological improvement following decortication was dramatic with immediate lung re-expansion and improvement of clinical course. Children were discharged by the sixth to nineth postoperative days. There were no complications and no deaths. We conclude that, early decortication is a safe and effective therapy for organizing and complicated empyema in children.

Key words: *Childhood, empyema, early decortication*

Introduction

The goals of any treatment of an empyema were outlined by Mayo and co-authors [14] in 1982: (1) to save life, (2) to eliminate the empyema, (3) to reexpand the trapped lung, (4) to restore mobility of chest wall and diaphragm, (5) to return respiratory functions to normal, (6) to eliminate morbidity, (7) to reduce the duration of hospital stay. Cardinal principles of treatment of empyema are, administration of appropriate antibiotics in combination with adequate drainage and full maintenance of lung expansion [3,7,15,16,23]. Clearly, some children do respond poorly or incompletely to this conventional therapy. More recent studies have attempted to identify the role of thoracotomy and decortication in the treatment of postpneumonic empyema [2,5,6,9,11,13,14,18,20,22,25].

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This study reviews the experience from 1993 to 1997 with 21 children who underwent early lung decortication for refractory and symptomatic postpneumonic empyema, and emphasizes the indications that led to early operative intervention.

Materials and Methods

Fiftyseven children who were treated for empyema at the Social Security Council Ankara Children's Hospital from June 1993 through December 1997 were included in this study. There were 34 boys and 23 girls, ranging in age from 3 months to 13 years. Diagnosis of empyema was made on the basis of clinical setting of pneumonia, with demonstration of pleural fluid accumulation on chest x-ray or computerized tomography (CT) scan. Soon after diagnosis, thoracentesis was performed in all patients. Thoracentesis has served to identify the nature of pleural fluid, provide material for Gram stain and culture, and allow removal of as much fluid as possible.

Pleural fluid obtained either by thoracentesis or via chest tube was also analysed for WBC count, pH, glucose, protein, lactic dehydrogenase (LDH). According to the results of these investigations, pathologic phase of empyema was defined in all patients. All children were started on a regimen of two wide spectrum intravenous antibiotics. The antibiotic coverage was subsequently changed depending on the culture and sensitivity results, and clinical status of the patient.

11 of 57 children with phase I empyema were initially treated with repeated thoracentesis however, closed pleural drainage with a large intercostal tube was required later in all patients.

In 17 patients with phase II empyema and 4 patients with phase III empyema, the conventional treatment by antibiotics and chest tube drainage failed. Before the operation, a thoracic CT scan was performed in 21 patients to define clearly the configuration of the pleural fluid collection and the degree of lung compression, and to differentiate parenchymal and pleural involvement.

All patients underwent a standard posterolateral thoracotomy incision. The pleural space was entered through fifth or sixth intercostal space without any rib resection. The ribs were spread with a retractor, and the fibrinous peel on the surfaces of the visceral and parietal pleurae was completely removed. Any major air leaks were sutured, pleural space was irrigated with sterile saline, and drained by one large chest tube. The chest was closed in layers with absorbable sutures and skin was closed primarily. Chest tube was left indwelling approximately 3-5 days postoperatively.

Results

Laboratory data

According to the results of pleural fluid examination, children with empyema were defined as phase I empyema in 11 cases, phase II empyema in 42 cases and phase III empyema in 4 cases. Table I summarizes the results of pleural fluid examination in each phase of empyema. All parameters tended to increase according to the severity of disease.

Table II summarizes the results of pleural fluid examination in each group of therapy. The most remarkable finding was the high protein levels of pleural fluid. All 21 children who showed inadequate cli-

Table I. Results of pleural fluid examination in each phase of empyema

Patients	pH <7.2	Glucose <40 mg/dl	LDH >1000 IU	Protein >5 gr/dl
Phase I empyema (n=11)	-	-	-	-
Phase II empyema (n=42)	22 (52 %)	21 (50 %)	34 (81 %)	16 (38 %)
Phase III empyema (n=4)	3 (75 %)	3 (75 %)	4 (100 %)	4 (100 %)

Table II. Results of pleural fluid examination in each group of therapy

Therapy groups	pH <7.2	Glucose <40 mg/dl	LDH >1000 IU	Protein >5 gr/dl
Medical therapy (Antibiotics+ thoracentesis+ chest tube drainage) (no=36)	10 (28 %)	11 (31 %)	19 (53 %)	
Decortication (n=21)	16 (76 %)	14 (67 %)	20 (95 %)	21 (100 %)

nical response to medical treatment ad underwent decortica-tion had a high level of protein (above 5 gr/dl) in their pleural fluid.

Radiological findings

Chest radiographs and CT scans obtained both during hospitalization and follow up of decortication for 57 patients are reviewed (Table III). Radiographs were evaluated for estimating the extent of pleural disease and the volume of the lung entrapped by the pleural peel. At the time of diagnosis, none of the patients with phase I empyema had evidence of lung compression over 10 %, while 29 of 42 patients with phase II empyema had lung compression between 10 % to 30 % (Figure 1 A,B) and 13 of 42 had lung compression between 30 % to 50 % (Figure 2 A,B).

4 children with phase III empyema had already >50 % lung compression at the time of diagnosis (Figure 3 A,B). The 25 patients with phase II empyema improved both clinically and radiographically and the compression of the lung regressed 10 to 20 percent following treatment.

Table III. Radiological evaluation of lung compression ratio in each phase of empyema

Lung compression	0-10 %	10 to 30 %	30 to 50 %	>50 %
Phase I empyema	11	-	-	-
Medical therapy	11	-	-	-
Decortication	-	-	-	-
Phase II empyema	-	29	13	-
Medical therapy	-	23	2	-
Decortication	-	6	11	-
Phase III empyema	-	-	-	4
Medical therapy	-	-	-	-
Decortication	-	-	-	4

In 17 patients with phase II empyema, lung compression progressed above 50 percent during the course of therapy. Also no regression of the lung compression was detected in the children with phase III empyema during therapy and decision of decortication was untertaken.

Bacteriological findings

A definitive bacteriological diagnosis was made in

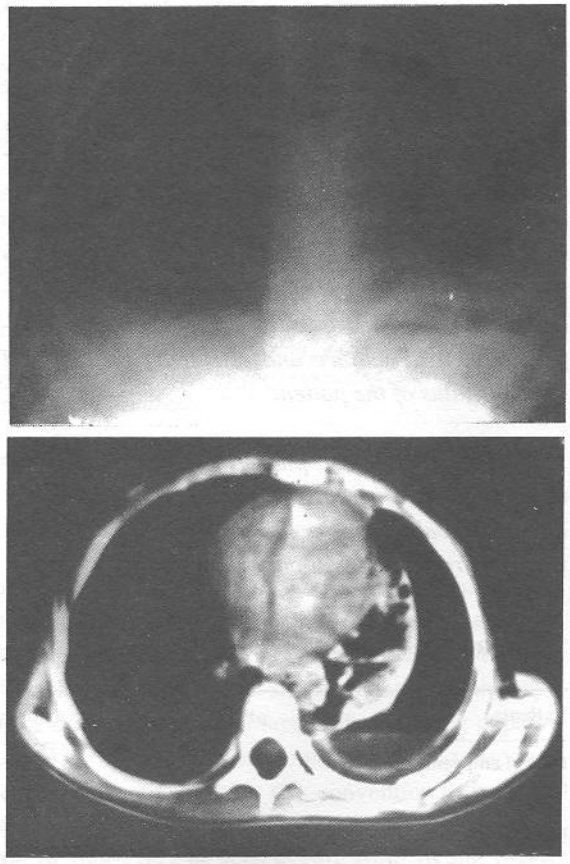

Figure 1A. Initial chest roentgenogram at the time of diagnosis shows pleural effusion and lung compression between 10 %-30 % of left hemithrorax. B. CT scan of patient at the time of diagnosis. Note a 30 % loss of lung expansion by the empyema.

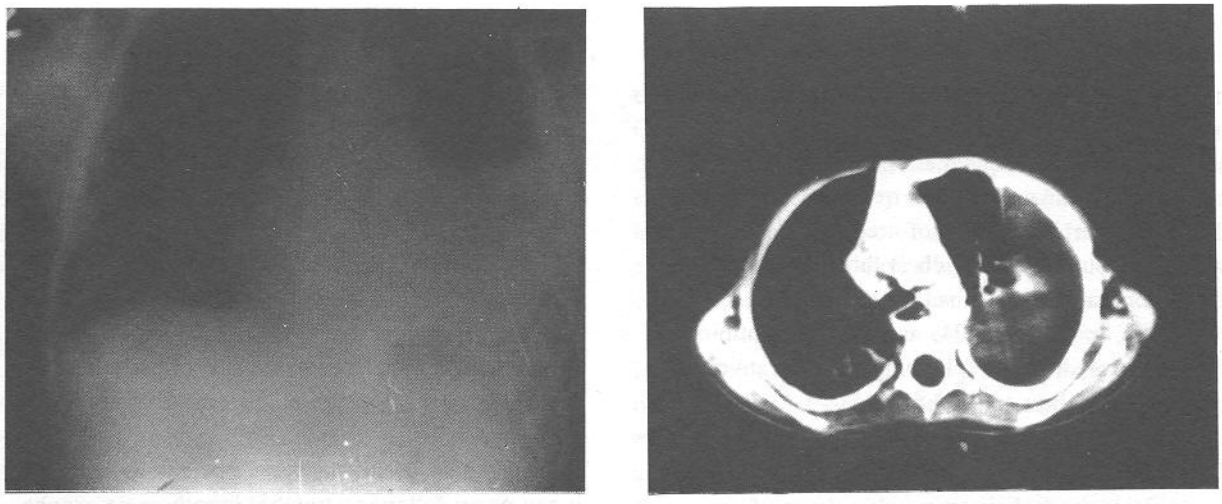

Figure 2A. Left lung opacification at admission. B. An extensive pleural peel entrapping the lung approximately 50 %.

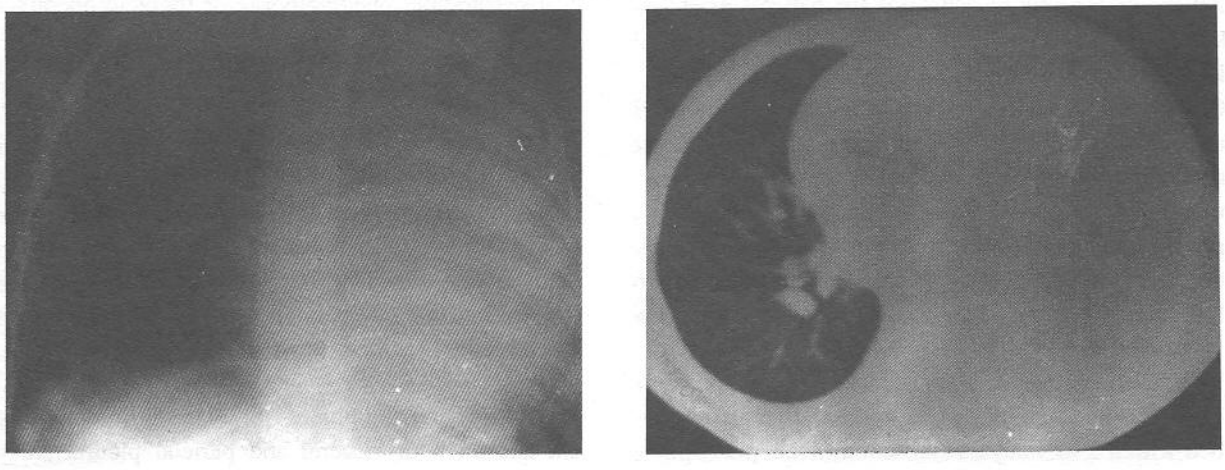

Figure 3A. Initial chest roentgenogram shows complete opacification of the left hemithorax. B. CT scan of the chest shows large amount of fibrinous debris, which almost completely collapsed the left lung.

Table IV. Bacteriological data

	Total	Medical therapy	Decortication
No growth	11	7	4
Pneumococcus	21	12	9
Staphylococcus sp.	18	13	5
Streptococcus sp.	3	2	1
Others (Pseudomonas, Hemophilus, E. coli, Anaerobes, Mycobacteria)	4	2	2

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46 of 57 patients (Table IV). 29 patients had positive pleural cultures only, 11 had a positive pleural fluid and blood culture, and 6 had a positive blood culture only. One patient with tuberculous empyema was identified after histological examination of material removed at the time of decortication. Pneumococcal and staphylococcal infections were the most common positive bacteriological identifications.

Indications for surgery

Failure of conventional therapy and indications for decortication were defined by the following criteria: (1) pleural thickening without resolution or with at least 50 % limitation of lung expansion in 21 patients, (2) persistent fever in 13 patients, (3) persistent respiratory distress in 5 patients, (4) pulmonary air leakage in 5 patients, (5) progression of parenchymal infiltrates in 3 patients. The presence of two or more criteria were accepted as indication for operation.

Analysis of the treatment modalities

11 patients with phase I empyema and 25 patients with phase II empyema were treated by antibiotics, thoracentesis and chest tube drainage. These patients spent an average of 21.3 days (19 to 25 days) in the

hospital. They received IV antibiotics for an average of 19.4 days (14 to 21 days). Decortication was reserved for the patients that antimicrobial therapy and closed-tube drainage failed in treatment and was undertaken after 6-15 days of treatment. Compared with the group treated by chest tube and antibiotics, the decortication group had shorter hospital stay (6 to 9 days, mean 7.8±1.04) and required antibiotics for a shorter duration following the operative procedure (3 to 5 days, mean 4.5±0.75).

Outcome

All the therapeutic measures of the patients are taken by the Pediatric Surgery and Infectious Diseases Departments of Social Security Council Ankara Children's Hospital. 35 of the 36 patients treated by antibiotics and chest tube drainage survived with one mortality (3 %). The child who died was a 6-month-old female with sepsis due to staphylococal pneumonia. She died on the fifth hospital day despite successful drainage of pleural space by a chest-tube.

There were no deaths in the decortication group. Recovery in all 21 patients was rapid and fever subsided within 2 to 4 days. Persistent air leak, post-operative bleeding or chlothorax was not observed in any of these patients and, none of them required a chest tube and antibiotics beyond the fifth post-operative day. Follow-up chest roentgenogram confirmed complete lung reexpansion (Figure 4). The patients were discharged from the hospital at an average of 7.8 days (6 to 9) after surgery. There has been no evidence of scoliosis, recurrent pleural or parencymal disease, restricted thoracic wall movement or respiratory complaints throughout the follow up period.

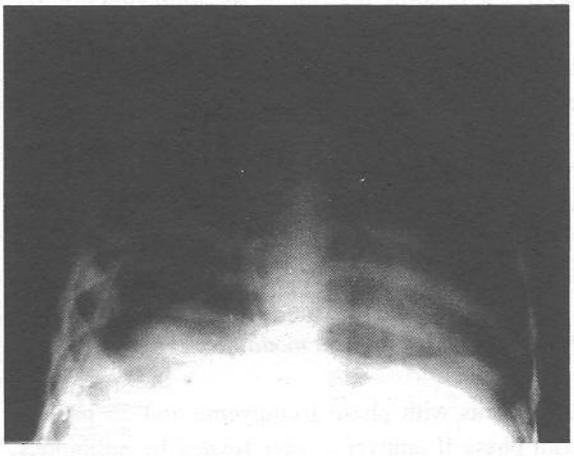

Figure 4. Immediately after decortication the right lung is aerated completely with minimal pleural reaction around the right lower lobe.

Discussion

Controversy still exist as to the role of early lung decortication in the current management of childhood post-pneumonic empyema. Empyema in childhood is usually a sequela of bacterial pneumonia, although it can occur following trauma, intrathoracic esophageal perforation, pneumothorax or thoracic operations. The pathologic response to an empyema can be divided into three distinct phases [1]:

1) The exudative phase reflects the immediate response with outpouring of fluid, which has a low cell count and can be removed by thoracentesis.
2) The fibrinopurulent phase is characterized by large quantities of pus, with many white cells and fibrin. As the fluid thickens, loculations begin to form and the lungs becomes progressively less expandable.
3) In the organizing phase, fibroblasts grow into the exudate on both visceral and parietal pleural surfaces, and produce a membraneous "peel". With increasing fibrosis, the process becomes chronic and the lung becomes more firmly fixed.

Treatment considerations should be based on the stage of the disease, the particular bacteria isolated, the response to initial treatment, and the degree of lung trapping [5,9,25]. The exudative and early fibrinopurulent phases of empyema can usually be treated by antibiotics and repeated thoracenteses, or more preferably closed chest-tube drainage [9]. Often, repeated thoracentesis only partially or intermittently reexpands the lung and chest tube drainage is required. In the late fibrinopurulent and organizing phases, prolonged pleural drainage is inadequate [6].

Treatment of patients with organizing fibrinopurulent empyema can be more difficult and is often associated with significant morbidity and mortality. Traditionally, efficient debridement and irrigation can only be accomplished through an open thoracotomy. As a result, proven surgical approaches to the

treatment of acute and early fibrinopurulent empyema include early open debridement and decortication [2,6,20,22]. Recently as an alternative to open drainage procedure and in an effort to avoid decortication thoracoscopic management of empyema has been advocated by some outhors [10,19]. Additionally, at this stage urokinase is used for fibrinolysis of thick material via chest tube [8,24].

Various investigators have suggested several laboratory analyses such as glucose and LDH content, and pH of pleural fluid, that may be helpful in predicting outcome of therapy [12,17,21]. Others have emphasized the importance of early roentgenographic findings in predicting disease severity and treatment outcome [1,4,13-15].

In our series, 11 patients were in phase I empyema, 42 in phase II empyema, and 4 in phase III empyema. As it is seen in Table I, pH and glucose content of pleural fluid tended to decrease while LDH and protein levels tended to increase with the severity of the disease. In the decortication group, 76 percent of patients showed a pH below 7.2, 67 percent of patients had a glucose level below 40 mg/dl, 95 percent of patients had LDH values above 1000 IU in pleural fluid.

In the decortication group, protein levels of pleural fluid were high (above 5 mg/dl) in all patients, conversely to the patients in the medical treatment group. Therefore, the protein level of the pleural fluid has been identified as one of the main prognostic factors of empyema in this series.

The CT scan greatly aids in delineating pleural disease and lung trapping from parenchymal disease. In our series, lung compression ratio was another main indication for decision of decortication. As seen in Table III, if the lung compression ratio is less than 30 % at the time of diagnosis, response to the medical therapy is high (79 %). In patients wih a lung compression ratio over 30 %, decortication must be considered strongly, since response to medical therapy is poor.

The clinical progress of these patients is of paramount importance. If the child is improving steadily, and the pleural material is diminishing, the medical treatment that is being used should be continued. Conversely, if the patient has an unresolving pleural thickening and showing complications such as persistent fever, respiratory difficulty and persistent air leakage despite the use of appropriate drainage and antibiotics, the child should be considered for the decortication [5,6,9,14,20].

In our series, 17 patients with phase II empyema did not respond to the conventional therapy and progressed to the organizing phase. Hence, pleural thickening without resolution (in all cases), persistent fever (in 13 cases), pulmonary air leakage (in 5 cases), respiratory distress (in 5 cases), and worsening infiltrates (in 3 cases) were observed.

Early decortication in our cases with refractory, symptomatic empyema resulted in immediate and complete reexpansion of the lung with no morbidity and mortality. Clinical improvement was marked, the child's hospital stay was shortened and the risk of long term antibiotic usage and pleural drainage was minimized.

We conclude that patients with a lung compression ratio over 30 %, and have a high protein and LDH levels in their pleural fluid, should be considered for decortication, since response to conventional therapy is poor. In these cases, decortication should be regarded not as a last resort, but as an early definitive therapy.

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