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Treatment of pediatric parapneumonic empyemas with pulmonary cavitary lesions

Pulmoner kaviter lezyonlar ile birlikte seyreden pediatrik parapnömonik ampiyemlerin tedavisi

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Background: This study aims to evaluate the treatment approach and timing of surgical intervention in pediatric parapneumonic empyema cases with cavitary lesions.

Methods: Between January 1990 and December 2006, 38 patients (21 boys, 17 girls; mean age 4.1+2 years; range 1 to 15 years) from the pediatric age group treated for parapneumonic empyema with cavitary lung lesions at the Dicle University Faculty of Medicine Department of Thoracic Surgery were retrospectively analyzed. The demographic characteristics, symptom duration, radiological examinations, treatment methods, and time to recovery of cavitary lesions during the hospitalization and follow-up were evaluated.

Results: A total of 13 patients (34%) were given medical treatment, while 25 (66%) underwent surgical treatment. The medical treatment group had a statistically significantly shorter inpatient duration than the surgical treatment group (p=0.010). Analysis of the postoperative inpatient duration revealed that the surgically treated patients stayed statistically significantly shorter in the hospital than the medical treatment group (p<0.001). A bronchopleural fistula (BPF) was found in eight (21%) patients and all were in the surgical treatment group. The mean time to recovery of cavitary lesions during follow-up was 48.7±8 days (range, 22-106 days).

Conclusion: Treatment of parapneumonic pediatric empyema cases with cavitary lesions should include controlling the pleural process with standard empyema treatment, considering pneumonia treatment as an integral part of the disorder, performing surgical treatment if a bronchopleural fistula is present or otherwise waiting patiently for the cavitary lesions to regress and postponing open surgical treatment until the recovery period is completed.

Key words: Cavitary pulmonary disease; pediatric empyema; pleural empyema.

Amaç: Bu çalışmada kaviter lezyonlarla seyreden pediatrik parapnömonik ampiyemlerde tedavi yaklaşımı ve cerrahi girişimin zamanlaması değerlendirildi.

Çalışma planı: Ocak 1990 - Aralık 2006 tarihleri arasında Dicle Üniversitesi Tıp Fakültesi Göğüs Cerrahisi Kliniği'nde parapnömonik ampiyem nedeni ile tedavi edilen hastalardan pediatrik yaş grubundaki ve kaviter akciğer lezyonları olan 38 hasta (21 erkek, 17 kız; ort. yaş 4.1+2 yıl; dağılım 1-15 yıl) retrospektif olarak incelendi. Hastaların demografik özellikleri ile birlikte, semptom süreleri, yapılan radyolojik incelemeler, tedavi yöntemi, hastanede kalış ve takip sürecinde kaviter lezyonların düzelme süreleri değerlendirildi.

Bulgular: Toplam 13 hastaya (%34) medikal, 25 hastaya (%66) cerrahi tedavi uygulandı. Medikal tedavi uygulanan hastaların, cerrahi tedavi uygulananlara kıyasla, istatistiksel olarak anlamlı derecede daha az süre hastanede yattığı saptandı (p=0.010). Ameliyat sonrası yatış süreleri incelendiğinde cerrahi tedavi uygulanan hastaların medikal tedavi uygulananlara göre istatistiksel olarak anlamlı derecede daha az hastanede kaldığı saptandı (p<0.001). Bronkoplevral fistül (BPF) sekiz hastada (%21) saptandı ve bu hastaların tamamı cerrahi uygulanan grupta idi. Hastaların takiplerinde kaviter lezyonların düzelme süresi ortalama 48.7±8 gün (dağılım 22-106 gün) olarak saptandı.

Sonuç: Kaviter lezyonlar ile seyreden parapnömonik pediatrik ampiyemlerin tedavisinde, standart ampiyem tedavisi ile plevral süreç kontrol altına alınmalı, pnömoni bütünün bir parçası olarak algılanıp tedavide gereken önem verilmeli, bronkoplevral fistül varlığında cerrahi tedavi gerekliliği yokluğunda ise sabırla kaviter lezyonların gerilemesi beklenip açık cerrahi işlemler düzelme dönemi bitene kadar bırakılmalıdır.

Anahtar sözcükler: Kaviter akciğer hastalıkları; pediatrik ampiyem; plevral ampiyem.

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Bacterial pneumonia causes pleural effusion in at least 40% of the cases in any age group, and more than 60% of these effusions progress to empyema.[1] Parapneumonic effusions in children have been treated with various methods, such as medical treatment and/or thoracentesis, tube thoracostomies, fibrinolytic agents, decortication and video-assisted thoracic surgery (VATS).[2] Inadequate control of the pleural process leads to the development of multiple loculations and organized empyema, which results in pleural thickening and restrictive respiratory disorders.[3] However, different treatments are used for parapneumonic empyema cases in which the pneumonia and empyema are concurrent than for postpneumonic empyema cases because they require simultaneous medical care for both the pneumonia and empyema. Furthermore, it takes a long time to treat pneumonia cases that cause pulmonary cavitation. The aim of this study was to evaluate the treatment approach and the timing of surgical intervention in pediatric parapneumonic empyema cases with cavitary lesions.

PATIENTS AND METHODS

A total of 38 pediatric patients (21 boys, 17 girls; mean age 4.1±2 years; range 1-15 years) treated for parapneumonic empyema with cavitary lung lesions between January 1990 and December 2006 at the Dicle University Faculty of Medicine Department of Thoracic Surgery were retrospectively evaluated in this study. The demographic features of the cases along with the symptom duration, radiological investigations, treatment methods, length of hospitalization, and recovery time for the cavitary lesions during follow-up were evaluated.

In a few patients, cavitary lung lesions were identified by chest X-ray at presentation, but a definitive diagnosis was usually made via thoracic computed tomography (CT). Patients presenting with total opacity underwent thoracentesis in conjunction with ultrasonography (USG) to avoid additional organ injury. A diagnosis of empyema was made when at least one of the following three criteria was present in the pleural fluid analysis: *(i)* Macroscopically purulent pleural fluid, *(ii)* A positive pleural fluid culture or positive Gram staining, or *(iii)* A pleural fluid glucose level of less than 40 mg/dl or a lactic dehydrogenase (LDH) level of over 1000 IU/L.

The cases were separated into two groups according to whether they had received medical or surgical treatment. The medical group included patients that had taken antibiotics or received fibrinolytic treatment or those who had undergone thoracentesis or a tube thoracostomy. The surgical group was composed of patients for whom medical treatment had not been successful; therefore, a thoracotomy with decortication, cavity obliteration, a wedge resection, a segmentectomy, or a lobectomy had been performed.

Upon admission, all patients underwent a tube thoracostomy. They all received intravenous sedation with midazolam and ketamine before this procedure, which was performed under operating room conditions using standard thoracic drainage tubes (14 or 20 F). After this, the pleural system was connected to a continuous thoracic aspirator at -20 cmH_2O pressure in the patients for whom a bronchopleural fistula (BPF) was not suspected. Fibrinolytic treatment was administered when the treatment produced less fluid drainage than expected, the effusion persisted radiologically, the thoracic USG showed loculations, or when the clinical response was inadequate, such as when the patient continued to have fever or respiratory symptoms. The fibrinolytic agent urokinase (1000 U/L) was added to 10-40 ml physiological saline and then administered to the pleural area from the thoracic tube, which was then clamped for one hour. Depending on the patient's response, this procedure was employed once per day for a mean duration of three days. The amount of drained fluid was monitored along with the radiological recovery. Fibrinolytic treatment success was defined as radiological regression of the pleural effusion and recovery in general symptoms (i.e. fever and shortness of breath). Any cases that did not respond successfully were referred for surgical treatment, and a muscle-sparing thoracotomy was performed. These cases were transferred back to the ward after one postoperative day in the intensive care unit (ICU). Diclofenac sodium, a nonsteroidal anti-inflammatory drug (NSAID), and acetaminophen were used for analgesic treatment. No deaths were reported in either the medical treated or surgically treated groups.

The duration of symptoms before presentation at the hospital and the time to recovery of the pulmonary cavitary lesions during the length of hospitalization and follow-up were evaluated.

All data was analyzed with the Statistical Package for Social Sciences (SPSS Inc., Chicago, Illinois, USA) version 15.0 for Windows, and the Mann-Whitney U test was used for inter-group comparisons. A p value below 0.05 was considered to be significant.

RESULTS

The mean duration between the start of the symptoms and presentation at the hospital was 15.3±7 days (range, 0-60 days). Chest X-rays at presentation showed pleural effusion in 20 patients, pneumothorax in five patients, with one being tension pneumothorax, and total

opacity in 13 patients, with four having mediastinal shift. Cavitary lesions could be seen in only nine (24%) of these patients. The thoracic CT showed multiple cavities in 14 patients (37%) (Figure 1). Eight of these received medical treatment while six underwent surgery. The locations and percentages of the cavitary lesions were presented in Table 1.

There was growth in the pleural fluid culture of nine patients (24%). Pneumothorax was present on presentation at our hospital in one of the three patients with *Pseudomonas aeruginosa* and one of the two patients with *Staphylococcus aureus* growth on the pleural fluid culture. *Enterobacter aerogenes*, *Enterobacter cloacae*, *Escherischia coli* and hemolytic *streptococcus* grew in the cultures of the other four patients.

Medical treatment was utilized for 13 patients (34%). Two of these underwent thoracentesis and nine had tube thoracostomies. Two patients received fibrinolytic treatment together with tube thoracostomies. The mean length of hospitalization was 22.4±5 days (range; 5-52 days) for the medically treated patients.

The surgical option was preferred for 25 patients (66%), and the techniques used are shown in Table 2. The mean time from hospital admission to surgery was 15.6±7 days (range; 2-33 days). The mean postoperative hospital stay of these patients was 12.3±6 days (range; 6-30 days), and the mean total length of hospitalization was 27.9±9 days (range; 14-48 days).

An analysis of the total length of hospitalization of the two different groups showed that those treated medically had significantly shorter inpatient duration than the surgically treated group (p=0.010). However, evaluation of the postoperative length of hospitalization revealed that the surgically treated patients stayed significantly shorter periods of time in the hospital than those who were treated medically (p<0.001).

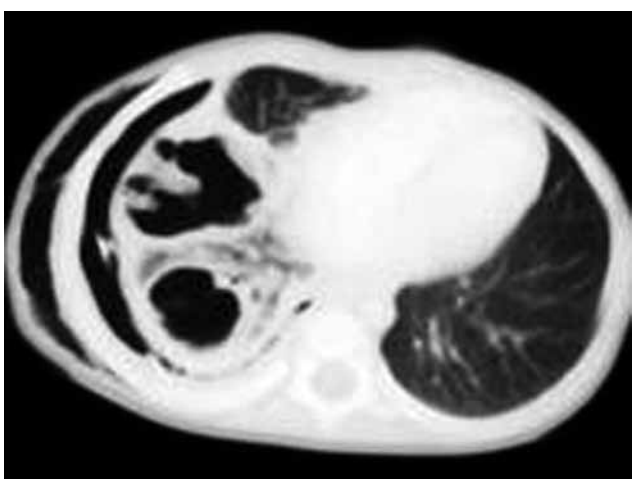

Figure 1. Thoracic computed tomography indicating the appearance of multiple cavities and pleural thickening in the right lung.

A BPF was found in eight patients (21%), and all of these cases were treated surgically. Decortication with fistula repair was performed on four of these patients. In addition, one patient underwent a wedge resection, one had a segmentectomy, one had cavity obliteration, and another underwent a lobectomy. The mean time to surgical treatment in cases operated on for BPF was 15.4±7 days (range; 10-29 days).

We experienced surgical complications due to an expansion defect in only four of the 25 surgically treated patients. All of these underwent decortication, This procedure was performed on a total of 14 cases, and the expansion defect was seen in an additional four patients (29%) postoperatively. The mean time to surgical treatment was 21.7±4 days (range; 18-26 days) in patients with complications and 16.5±9 days (range; 2-33 days) in those without. There was no statistically significant difference between the two groups (p=0.16). Postoperative hospital stay time was found to be significantly higher in the postoperative complication group (expansion defect) when compared with the BPF group (23.5±19.22 versus 18.3±7.52 days; p=0.05).

For the patients who experienced postoperative complications, we compared the time to surgical treatment between the patients with BPF (n=8) and those without (n=17), and there was no statistically significant difference (p=0.100). There was also no significant difference between the time to surgical treatment when patients with BPF were compared with those without complications (p=0.658).

The mean duration of hospitalization for all patients in the medically treated and surgically treated groups was 25.6±10 days (range; 5-52 days), and the mean time for recovery of those with cavitary lesions during follow-up was 48.7±8 days (range; 22-106 days).

Table 1. Locations and percentages of the cavitary lesions

	Right lung		Left lung		*Total*	
	n	%	n	%	n	%
Upper lobe	13		4		17	45
Lower lobe	7		10		17	45
Middle lobe	2		–		2	5
Upper + lower lobe	2		–		2	5
Total	24	63	14	37	38	100

Table 2. Surgical techniques used and their percentages

Surgical technique	Number of cases	%
Decortication	14	56
Decortication + cavity obliteration	4	16
Decortication + wedge resection	1	4
Decortication + segmentectomy	3	12
Decortication + lobectomy	3	12
Total	25	100

DISCUSSION

Pulmonary cavitating diseases are classified as either non-infectious or infectious. The non-infectious group consists of malignancies, rheumatological diseases, and various cavitizing disorders, whereas the infectious group is made up of bacterial, fungal, and parasitic diseases.[4] Both pleural empyema and lung abscesses are examples of lower pulmonary track infections. Lung abscesses develop as a result of cavitation and necrosis development in a localized parenchymal infection and were encountered frequently in the days before antibiotic usage. Now they are rarely seen, but when they do occur, 90% of the cases recover with the use of antibiotics.[5] This condition must not be confused with the pneumatocele seen in *Staphylococcus pneumonia*. However, this differentiation was easy in our patients as the cavitary lesions did not show any change on radiological imaging. Surgery is recommended for lung abscesses in the presence of complications such as BPF and pleural empyema.[6]

Pneumonia is a common childhood disease, with an incidence of 1.0 to 4.5 per 100 children annually, and it generally responds well to antibiotic treatment.[1] Nevertheless, complications due to the development of pleural effusion can develop that may progress to empyema.[7] It is usually difficult to define the causative factor of empyema in children. Therefore, empirical rather than specific treatment is preferable.[1] We also treated 29 (76%) of our patients with empirical antibiotic treatment. It is recommended that treatment of pneumonia cases with cavitary lesions be continued until the foul-smelling sputum and abscess fluid disappear, the abscess cavity is closed, or its size is constant for two to three weeks. Hence, prolonged treatment is not uncommon.[8] Studies have shown a mean time to full closure of cavitary lesions of 65 days.[8,9] The mean duration for our patients was 48.7±8 days (range; 22-106 days).

There is no consensus on the optimum treatment strategy for advanced empyema. Alternatives include intrapleural fibrinolytic administration, thoracoscopies, and thoracotomies.[10-13]

The British Thoracic Society (BTS) has recommended the use of intrapleural fibrinolytics for all cases of complicated pediatric parapneumonic effusion or empyema.[14] Urokinase, a recommended fibrinolytic agent, has been used in many multicenter studies on large groups, including pediatric patients, and it was found to decrease inpatient stays significantly when compared with the placebo group.[10] Urokinase was utilized for intrapleural fibrinolytic treatment in two of our patients with successful results.

A thoracoscopy is currently preferred for its low morbidity and short inpatient stay, but the definite prognostic factors of the empyemas treated in this way are uncertain.[3] However, this surgical procedure is more invasive and expensive than fibrinolytic treatment; therefore, it is not recommended as the primary local treatment of complicated parapneumonic effusion/empyema in children.[7] A comparison of clinical results has shown that fibrinolytic treatment is as effective as VATS.[15,16] Thus, determining the proper treatment method and predicting postoperative disease progression is vital for the timing of surgical treatment.[3] None of the patients in our surgical group underwent VATS.

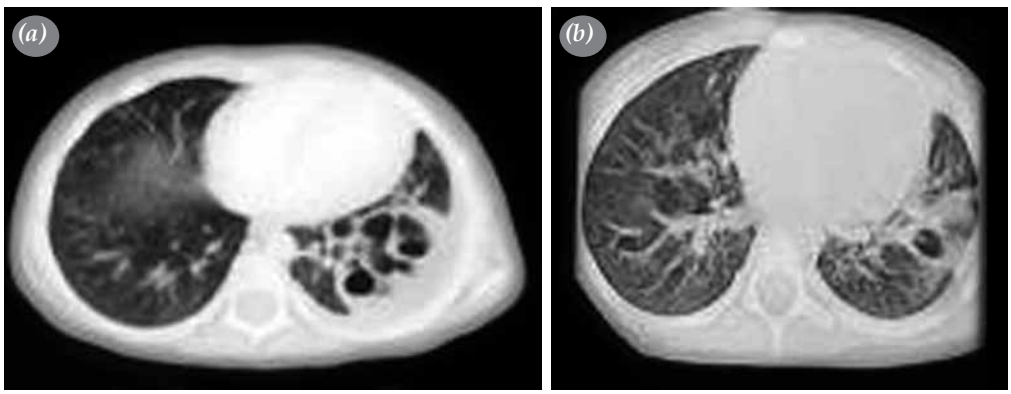

Figure 2. (a) Multiple cavities in the left lung before medical treatment. **(b)** Thoracic computed tomography image after a month of medical treatment.

Surgical debridement and decortication should be reserved for empyema patients who are resistant to medical treatment.[1] However, pneumonia must not be forgotten when surgery is performed since empyemas are usually a complication of pneumonia. Therefore, the treatment of parapneumonic empyema must be directed towards both the pneumonia and the empyema. The use of surgical decortication for empyema in the presence of active pneumonia will frequently lead to postoperative complications. The fact that an expansion defect developed in four (29%) of the 14 patients undergoing decortication in our study supports this notion. The presence of a BPF is one of the most significant indication for surgery, as we saw in this retrospective study. It is not necessary to wait for the regression of cavitary lesions in patients with a BPF, and surgery should be performed as early as possible once the patient is stable. In the surgical treatment group in our study, there was no BPF in 17 patients, and 14 of the 17 patients underwent only decortication. However, these patients had cavitary lesions and pneumonia before the surgery. Our experience with patients with a BPF, including those with surgical complications (expansion defect), led us to conclude that the decortication procedure alone is not sufficient for treating cavitary lesions without complications. Because we used more complex surgical techniques, such as decortication plus cavitary obliteration in the BPF group, the results were more successful, and our patients experienced fewer complications. When there were complications, the hospital stay time was significantly longer than for uncomplicated surgical procedures. In light of our data, we believe that if there is a definitive indication for surgery, such as a BPF, complex surgical procedures should not be delayed. It is also possible to choose surgery for cavitary lesions, even when there are no direct indications that an operation is necessary, since postoperative complications can be avoided with this option, and patients can have shorter hospital stays.

In conclusion, treatment of parapneumonic pediatric empyema cases with cavitary lesions should include standard treatment methods for controlling the pleural process. In addition, it is important for medical professionals to not neglect the possibility of pneumonia in these cases as it is an integral part of the disorder. We recommend that clinicians use the surgical treatment option if a BPF is present. Otherwise, we think that they can wait patiently for the cavitary lesions to regress and postpone the open surgical treatment option until the recovery period.

Declaration of conflicting interests

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REFERENCES

1. Schultz KD, Fan LL, Pinsky J, Ochoa L, Smith EO, Kaplan SL, Brandt ML. The changing face of pleural empyemas in children: epidemiology and management. Pediatrics 2004;113:1735-40.
2. Gates RL, Hogan M, Weinstein S, Arca MJ. Drainage, fibrinolytics, or surgery: a comparison of treatment options in pediatric empyema. J Pediatr Surg 2004;39:1638-42.
3. Kalfa N, Allal H, Lopez M, Saguintaah M, Guibal MP, Sabatier-Laval E, et al. Thoracoscopy in pediatric pleural empyema: a prospective study of prognostic factors. J Pediatr Surg 2006;41:1732-7.
4. Gadkowski LB, Stout JE. Cavitary pulmonary disease. Clin Microbiol Rev 2008;21:305-33.
5. Erasmus JJ, McAdams HP, Rossi S, Kelley MJ. Percutaneous management of intrapulmonary air and fluid collections. Radiol Clin North Am 2000;38:385-93.
6. Huang HC, Chen HC, Fang HY, Lin YC, Wu CY, Cheng CY. Lung abscess predicts the surgical outcome in patients with pleural empyema. J Cardiothorac Surg 2010;5:88.
7. Krenke K, Peradzynska J, Lange J, Ruszczynski M, Kulus M, Szajewska H. Local treatment of empyema in children: a systematic review of randomized controlled trials. Acta Paediatr 2010;99:1449-53. doi: 10.1111/j.1651-2227.2010.01863.x.
8. Finegold SM, Fishman JA. Empyema and lung abscess. In: Fishman AP, editor. Pulmonary diseases and disorders. New York: McGraw Hill; 1998. p. 2021-33.
9. Bartlett JG. Anaerobic bacteria (aspiration pneumonitis and lung abscess). In: Bone RC, Dantzker DR, George RB, Matthay RA, Reynolds HY, editors. Pulmonary and critical care medicine. St Louis: Mosby-Year Book Inc.; 1998. p. 1-11.
10. Thomson AH, Hull J, Kumar MR, Wallis C, Balfour Lynn IM. Randomised trial of intrapleural urokinase in the treatment of childhood empyema. Thorax 2002;57:343-7.
11. Yao CT, Wu JM, Liu CC, Wu MH, Chuang HY, Wang JN. Treatment of complicated parapneumonic pleural effusion with intrapleural streptokinase in children. Chest 2004;125:566-71.
12. Kercher KW, Attorri RJ, Hoover JD, Morton D Jr. Thoracoscopic decortication as first-line therapy for pediatric parapneumonic empyema. A case series. Chest 2000;118:24-7.
13. Karaman I, Erdoğan D, Karaman A, Cakmak O. Comparison of closed-tube thoracostomy and open thoracotomy procedures in the management of thoracic empyema in childhood. Eur J Pediatr Surg 2004;14:250-4.
14. Balfour-Lynn IM, Abrahamson E, Cohen G, Hartley J, King S, Parikh D, et al. BTS guidelines for the management of pleural infection in children. Thorax 2005;60 Suppl 1:i1-21.
15. Sonnappa S, Cohen G, Owens CM, van Doorn C, Cairns J, Stanojevic S, et al. Comparison of urokinase and video-assisted thoracoscopic surgery for treatment of childhood empyema. Am J Respir Crit Care Med 2006;174:221-7.
16. St Peter SD, Tsao K, Spilde TL, Keckler SJ, Harrison C, Jackson MA, et al. Thoracoscopic decortication vs tube thoracostomy with fibrinolysis for empyema in children: a prospective, randomized trial. J Pediatr Surg 2009;44:106-11.