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Original Article

The Effects of Pleural Decortication on Respiratory Functions of the Patients with Pleural Empyema

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ABSTRACT

Objective: Pleural empyema is a collection of purulent liquid in the cavity between the visceral and parietal pleura developing during the postinflammatory period. It can have a high morbidity and mortality rate if not treated. The aim of this study was to spirometrically evaluate respiratory function in patients before and after decortication surgery, which is a treatment used in late phase, chronic pleural empyema.

Methods: Patient files were evaluated retrospectively according to the criteria of the study. Forced expiratory volume-1 second (FEV1), forced vital capacity (FVC), and FEV1/FVC% values measured in the week before surgery and 6 months after the procedure were then compared with preoperative values.

Results: A significant improvement was seen in spirometric values. The mean preoperative values of FVC 2.33±0.71 L, FEV1 1.91±0.56 L, and FEV1/FVC% 82.77±8.50% increased postoperatively to 2.64±0.65 L (p=0.000), 2.28±0.57 L (p=0.000), and 86.52±7.47% (p=0.014), respectively. The increase in postoperative values for FVC, FEV1, and FEV1/FVC% were 13.3%, 19.3%, and 4.53%, respectively. These results were statistically quite significant for FVC, FEV1, and significant for FEV1/FVC.

Conclusion: The results indicate that decortication is an effective operation to treat eligible stage III empyema patients.

INTRODUCTION

Purulent fluid forming after the inflammatory process in the anatomical cavity between the visceral and parietal pleural layers is called pleural empyema. If not treated, it has a high rate of mortality and morbidity.[1] Pleural empyema has exudative, fibrinopurulent, and organized phases. In the last phase, called chronic pleural empyema, a fibrous capsule develops that restricts lung expansion.

Massive effusion developing in the pleural space, inadequate aspiration, and premature septation constitute indications for drainage. Timely insertion of a chest tube and drainage of the fluid can prevent progression of the disease.[2] The introduction of video- assisted thoracoscopic surgery (VATS) represented a new treatment option in in the management of pleural empyema. It is recommended that VATS be used when a tube thoracostomy fails to evacuate multilocular empyema or when the disease progresses to the fibrinopurulent phase.[3]

The accumulation of purulent fluid in the pleural space and the thickening of the pleura restrict expansion and movement of the lungs.

Entrapment of the lungs by the pleura leads to secondary atelectasis and changes in the ventilation-perfusion rates.[4] The aim of surgery is to excise this thickened pleura and remove the restriction in the chest cavity. The most common surgical method is decortication. A review of the literature indicates that although there are reports stating that decortication surgery led to little or no improvement in lung function, generally, favorable effects have been observed on spirometric parameters of total lung capacity

(TLC), vital capacity (VC), forced expiratory volume in 1 second (FEV1), and forced expiratory volume (FEV).[4,5]

Some studies have also reported that reduced ventilation, perfusion, and oxygen uptake in atelectatic lungs improved after the lung was re-expanded.[6-8]

The aim of this study was to evaluate pulmonary function before and after surgery in patients who underwent lung decortication due to pleural empyema and to compare the results obtained with those in the literature.

MATERIAL AND METHODS

The files of a total of 50 patients who underwent decortication surgery between January 2009 and January 2015 were evaluated retrospectively for inclusion in the study.

The diagnosis of pleural empyema was based on clinical findings, imaging, and laboratory results. Patients with radiologically detected multiloculated pleural effusion and pleural thickening, elevation of the diaphragm, intercostal narrowing, or mediastinal shift were included in the study. The exclusion criteria were poor health status; the detection of parenchymal damage using imaging modalities; the presence of comorbid conditions, such as chronic liver or kidney disease, or recent myocardial infarction; the presence of metastatic or pleural malignancy; and patients who underwent debridement with VATS. Seventeen patients under 16 years of age were also excluded because the pulmonary function test results were incomplete.

The final study group (n=33) underwent pulmonary function tests (spirometry) preoperatively and 6 months after the operation. Patients who underwent thoracoscopic decortication (n=2), those with histopathologically detected malignancy after decortication (n=3), and cases in which parenchymal resection was performed during decortication (n=2) were excluded. As a result, the study population consisted of 26 patients (21 males [80.76%] and 5 females [19.24%]). The median age of the patients was 44.73 years (range: 22-73 years). Empyema was localized in the right hemithorax in 19 (73%) and in the left hemithorax in 7 patients (27%). The choice of treatment was based on the patients' thoracic computed tomography (CT) findings and general condition. The preoperative pulmonary function test was performed using a spirometer within the week before the operation.

All of the patients underwent a preoperative chest X-ray, thoracic CT, and routine blood, urine, and microbiological sputum examinations. Selected patients also underwent a bronchoscopy (n=15). A tube thoracostomy (n=9) was performed for patients with massive pleural effusion and dyspnea with systemic findings of infection (such as fever, leukocytosis, elevation of sedimentation). Respiratory physiotherapy was performed pre- and postoperatively for all patients. Preoperative blood transfusions and nutritional support were also provided to the patients as needed.

The etiology of the empyema was nonspecific pleural empyema secondary to parapneumonic effusion (n=18), tuberculous empyema (n=5), and empyema secondary to hemothorax (n=3). The diagnosis of tuberculous empyema was made based on acid-fast staining of the resected material and detection of typical caseous necrosis. Antituberculostatic treatment was administered to 3 patients with tuberculous empyema for 6 months before surgery. Two patients were diagnosed after the operation. All of the tuberculous empyema patients had negative acid-fast bacilli sputum results prior to surgery. *Staphylococcus aureus, Streptococcus pneumaniae, Enterococcus* and some anaerobic organisms were detected in the microbiological examinations of patients with non-tuberculous empyema. All of the patients were treated with empirical broad-spectrum antibiotics until a specific organism was identified.

A standard posterolateral thoracotomy incision was made in all of the study cases. The thoracic cavity was entered through the sixth intercostal space. Rib resection was not performed in any patient who underwent thoracotomy. Areas of pleural thickening and empyema in the parietal wall were separated away from the chest wall with extrapleural dissection. Both parietal and visceral pleura were completely decorticated. Parenchymal air leaks that developed during decortication were carefully repaired and mechanical irrigation was applied to the thoracic cavity. The purpose of these procedures was to achieve a complete empyectomy. The surgical goal was to achieve improved chest wall and diaphragm movements, re-expansion of the lung, and a sterile pleural space. Two thoracic drains (basal lobe: 36-F, apical lobe: 32-F) were used. During the operation, 12 patients required 1 unit of erythrocyte suspension, 7 patients required 2 units, and 3 patients required 3 units. For postoperative analgesia, an intercostal blockade with bupivacaine and nonsteroidal anti-inflammatory drug treatments was applied. Narcotic analgesics were provided when these treatments were inadequate. Patient-controlled analgesia was used in some cases.

FVC, FEV1, and FEV1/FVC% values were analyzed based on pulmonary function tests. Postoperative changes in the analyzed values were calculated as follows: Rate of change = [(post-operative volume-preoperative volume) / preoperative volume] x 100.

Physical examinations were performed at the outpatient clinic at the first and sixth month following of decortication, a chest X-ray was obtained, and spirometric examinations were performed. The spirometric analysis performed at the sixth month after decortication yielded the control data used for comparison.

The data were analyzed using SPSS for Windows, Version 15.0 (SPSS Inc., Chicago, IL, USA). A paired Student's t-test

was used to evaluate the statistical significance of the study data. A p value <0.05 was considered statistically significant.

RESULTS

A total of 26 cases of decortication surgery that was performed during the study period were assessed: 5 female (19%) and 21 male (81%) patients. The age of the patients ranged between 22 and 73 years, with a mean age of 46.50±15.30 years. The age and gender characteristics of the patients are shown in Table 1.

Table 1. Age and gender distribution of decortication patients

Age (years)	Male		Female		Total	
	n	%	n	%	n	%
20-29	4	19	-		4	15.4
30-39	4	19	1	20	5	19.2
40-49	4	19	2	40	6	23.1
50-59	5	24	1	20	6	23.1
>60	4	19	1	20	5	19.2
Total	21	100	5	100	26	100
Mean±SD					46.52±15.30	

Table 2. Distribution of some clinical findings

	n	%
Cough	19	73
Weight loss	17	65.4
Dyspnea	13	50
Chest pain	11	42.3
Fever	8	30.8

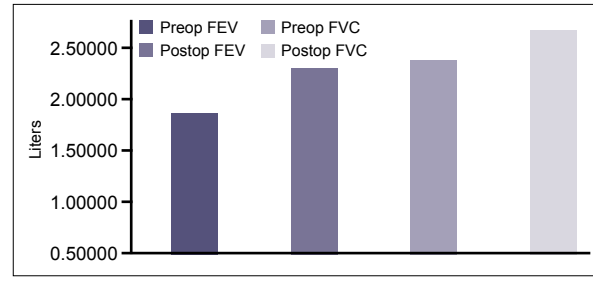

Figure 1. Illustration of the change between pre- and postoperative FEV1 and FVC values.
FEV1: Forced expiratory volume-1second; FVC: Forced vital capacity.

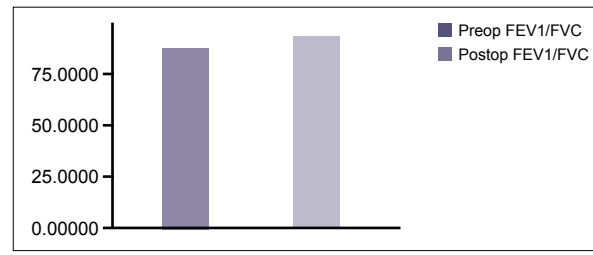

Figure 2. Graphical representation of the changes between pre- and postoperative FEV1/FVC% values.
FEV1: Forced expiratory volume-one second; FVC: Forced vital capacity.

The diagnosis of pleural empyema was based on clinical findings (such as fever, chills, chest pain), chest X-ray, and thoracic CT findings. The patient history revealed a cough in 73%, weight loss in 65.4%, dyspnea in 50%, and chest pain in 42.3% of the group (Table 2).

A significant improvement in the spirometric values was observed after decortication (Table 3, Figs. 1, 2). The preoperative values of FVC: 2.33±0.71 L, FEV1: 1.91±0.56 L, and FEV1/FVC%: 82.77±8.50% (p=0.000) increased to 2.64±0.65 L (p=0.000), 2.28±0.57 L (p=0.000), and 86.52±7.47% (p=0.014), respectively. The percentage change in the postoperative FVC, FEV1, and FEV1/FVC% values was 13.3%, 19.3%, and 4.53%, respectively. These results were statistically significant for FVC and FEV1, and significant for FEV1/FVC%.

Table 3. Pre- and postoperative spirometric values

Spirometric parameters	Preop	Postop (6th month)	% Change	p
	Mean±SD	Mean±SD		
FVC	2.33±0.71	2.64±0.65	13.3	0.000
FEV_1	1.91±0.56	2.28±0.57	19.3	0.000
$\%FEV_1/FVC$	82.77±8.50	86.52±7.47	4.53	0.014

FEV_1: Forced expiratory volume-1 second; FVC: Forced vital capacity.

Table 4. Changes in spirometric parameters in cases with empyema secondary to tuberculous and non-tuberculous etiologies

	Tuberculous (n=5)				Non-Tuberculous (n=21)		
	Preop	Postop	p	% Change	Preop	Postop	P
FEV1	2.26±0.66	2.60±0.51	0.041	15.04	0.82±0.52	2.20±0.57	0.000
FVC	2.71±0.94	3.06±0.68	0.010	12.9	2.24±0.64	2.53±0.61	0.000
FEV_1/FVC %	82.46±13.6	82.8±11.3	0.017	0.41	82.85±7.24	86.2±6.58	0.079

FEV_1: Forced expiratory volume-1 second; FVC: Forced vital capacity.

Table 5. Time until removal of the drains and discharge of the patients

	Time to removal of the first drain (days)	Time to removal of the second drain (days)	Duration of hospital stay (days)
Ortalama	3	6	7
Min-Maks.	1-10	2-20	2-22

When the results of the tuberculous and non-tuberculous empyema cases were analyzed, a 15.04% increase in FEV1 was seen, 12.9% in FVC, and 0.41% in FEV1/FVC (p=0.041, 0.010, and 0.017 respectively). Generally, the results were statistically significant, while the values were quite significant in the non-tuberculous empyema group, (Table 4).

The thoracic drain in the basal lobes was withdrawn when the drainage quantity dropped below 100 mL (an average of 3 days after surgery). The apical drain was removed when the air leak ceased (an average of 6 days after surgery). The patients were discharged according to their general condition and control chest X-ray findings (an average of 7 days after surgery) (Table 5).

DISCUSSION

Pleural empyema is assessed in 3 phases. If the initial exudative phase is not diagnosed in time and not treated effectively, the disease rapidly progresses to the fibrinopurulent phase. The purpose of surgery at this phase is to dissect away the fibrous septa and to drain the pus and fluid from the pleural space. Although tube thoracostomy is usually performed, open surgery can be used in cases where drainage is not fully achieved. Though pediatric cases were not included in our study, Demirhan et al.[9] reported that in cases of pediatric empyema, decortication could be performed when the tube thoracostomy was inadequate for drainage. With the increasing frequency of the use of VATS, several studies have demonstrated that it is one of the most effective treatment options for the fibrinopurulent phase.[10,11] VATS alleviates the patient's pain, shortens the duration of the operation, allows drains to be withdrawn earlier, and decreases the length of hospital stay. However, once the disease reaches the third stage, the results may not be as favorable.

During the early stages of the third phase of empyema the proliferation of fibroblasts and the development of the fibrin layer result in the formation of fibrous tissue. When the fibrous tissue matures, a thick layer forms between the visceral and parietal pleura. The resulting layer restricts expansion of the lungs and impairs perfusion. The ventilation of the non-expansive lung gradually decreases, resulting in atelectasis and inadequate respiratory function. If this phase of empyema remains untreated, it may cause parenchymal damage and chest deformities.

The most effective treatment option in this phase is decortication. The purpose of this operation is to ensure full debridement of the pleura and re-expansion of the lungs without air leakage or dead space. Decortication is generally thought to improve respiratory function tests. However, in the literature, the results of studies examining the effects of this operation on pulmonary functions are contradictory. Some studies have reported that the lung was functionally improved, while others found that spirometric parameters deteriorated.[12,13]

In our study, the preoperative and postoperative spirometric parameters of the patients were compared and the results were found to be quite significant ($p<0.05$). As in other studies, our research revealed favorable results in FVC and FEV1 values: The rate of increase in spirometric parameters after decortication was more than 10%. Our findings were consistent with studies reporting that decortication had positive effects on respiratory functions.

In some studies it has been shown that the improvement in pulmonary function after decortication due to empyema in the right hemithorax was slightly better than in the left hemithorax.[14] This can be attributed to the fact that right lung volume is greater than that of the left.

Studies have also shown that spirometric parameters after decortication do not improve when tuberculosis and destructive pulmonary diseases are predominant etiological factors.[15,16] In our study, there were only a small number of cases with tuberculous empyema and with less severe disease and parenchymal involvement. The FEV1, FVC, and FEV1/FVC% values increased by 15.04%, 12.9%, and 0.41%, respectively (p=0.041, 0.010, 0.017, respectively). These values were statistically significant and consistent with studies in the literature.

A lack of improvement in spirometric functions after decortication in tuberculous empyema can be explained by trapped lungs restricting pulmonary functions and leading to a decrease in lung volume and carbon monoxide transfer, with an increase in residual volume/total lung capacity. At the same time, parenchymal damage is present in the majority of patients, since tuberculosis-associated pleural disease is caused by the spread of the parenchymal disease.

In such cases, the fibrous layer that restricts lung expansion may be removed, but there may not be an effective spirometric improvement. Atelectasis caused by parenchymal damage results in alveolar collapse. Alveolar collapse also causes vasoconstriction in the lung arterioles and increases resistance in lung circulation. Following vasoconstriction, the perfusion of the trapped lung is further reduced. This is why the perfusion defect in the affected half of the lung is worse than the ventilation defect.[5, 17]

For this reason, we did not include tuberculosis patients with radiologically demonstrated parenchymal damage in our study. The mortality rate of cases with tuberculosis-related chronic pleural empyema is considerably higher than that of empyema due to other causes. Postoperative mortality was not observed in our patient group. In a study of 26 patients who underwent decortication, only 2 patients underwent surgery due to tuberculosis and the increase in FVC and FEV1 values was 15% and 20%, respectively. In another study, similar results of decortication performed for patients with pleural empyema with tuberculous (n=14), and non-tuberculous (36) etiologies were reported. In this study, improvement in the spirometric parameters of FEV1 and FVC, as well as long-term and prominent improvements in lateral and anterior chest wall diameters were seen following decortication surgery. In the above-mentioned study, the patients obtained comparable benefits from operations performed for empyema in the right or left hemithorax, and empyema with tuberculosis or nontuberculous etiology.[14]

CONCLUSION

In this study, it was determined that the postoperative pulmonary function test results improved significantly in patients who underwent decortication surgery due to pleural empyema. The results of our research are consistent with the literature and demonstrate the benefit of decortication. We believe it to be an effective treatment for stage III pleural empyema in appropriate cases.

Ethics Committee Approval

Retrospective study.

Peer-review

Internally peer-reviewed.

Authorship Contributions

Concept: K.B.Ö.; Design: R.D.; Data collection &/or processing: A.Ö.; Analysis and/or interpretation: E.E.C.; Literature search: M.T.; Writing: K.B.Ö.; Critical review: K.B.Ö., R.D.

Conflict of Interest

None declared.

REFERENCES

1. Kim BY, Oh BS, Jang WC, Min YI, Park YK, Park JC. Video-assisted thoracoscopic decortication for management of postpneumonic pleural empyema. Am J Surg 2004;188:321–4. [CrossRef]
2. Carey JA, Hamilton JR, Spencer DA, Gould K, Hasan A. Empyema thoracis: a role for open thoracotomy and decortication. Arch Dis Child 1998;79:510–3. [CrossRef]
3. Roberts JR. Minimally invasive surgery in the treatment of empyema: intraoperative decision making. Ann Thorac Surg 2003;76:225–30.
4. Choi SS, Kim DJ, Kim KD, Chung KY. Change in pulmonary function following empyemectomy and decortication in tuberculous and non-tuberculous chronic empyema thoracis. Yonsei Med J 2004;45:643–8. [CrossRef]
5. Rise TW. Fibrothorax and decortication of the lung. In: Shields TW, LoCicero J III, Ponn RB, editors. General Thoracic Surgery. 5th ed. Philadelphia: Lippincott Williams & Wilkins; 2000. p. 729–37.
6. Long ET, Adams WE, Benfield JR, Mikouchi T, Reimann AF, Nigro S. Altered hemodynamics in the pulmonary circulation following reaeration of an atelectatic lung. J Thorac Cardiovasc Surg. 1960;40:640–52.
7. Rzyman W, Skokowski J, Romanowicz G, Lass P, Dziadziuszko R. Decortication in chronic pleural empyema - effect on lung function. Eur J Cardiothorac Surg 2002;21:502–7. [CrossRef]
8. Webb WR, Burford TH. Studies of the reexpanded lung after prolonged atelectasis. AMA Arch Surg 1953;66:801–9. [CrossRef]
9. Demirhan R, Kosar A, Sancakli I, Kiral H, Orki A, Arman B. Management of postpneumonic empyemas in children. Acta Chir Belg 2008;108:208–11. [CrossRef]
10. Luh SP, Chou MC, Wang LS, Chen JY, Tsai TP. Video-assisted thoracoscopic surgery in the treatment of complicated parapneumonic effusions or empyemas: outcome of 234 patients. Chest 2005;127:1427–32. [CrossRef]

11. Solaini L, Prusciano F, Bagioni P. Video-assisted thoracic surgery in the treatment of pleural empyema. Surg Endosc 2007;21:280–4.
12. Rzyman W, Skokowski J, Romanowicz G, Lass P, Murawski M, Taraszewska M, et al. Lung function in patients operated for chronic pleural empyema. Thorac Cardiovasc Surg 2005;53:245–9. [CrossRef]
13. García-Yuste M, Ramos G, Duque JL, Heras F, Castanedo M, Cerezal LJ, et al. Open-window thoracostomy and thoracomyoplasty to manage chronic pleural empyema. Ann Thorac Surg 1998;65:818–22. [CrossRef]
14. Gokce M, Okur E, Baysungur V, Ergene G, Sevilgen G, Halezeroglu S. Lung decortication for chronic empyaema: effects on pulmonary function and thoracic asymmetry in the late period. Eur J Cardiothorac Surg 2009;36:754–8. [CrossRef]
15. Patton WE, Watson TR Jr, Gaensler EA. Pulmonary function before and at intervals after surgical decortication of the lung. Surg Gynecol Obstet 1952;95:477–96.
16. Thomas GI, Jarvis FJ. Decortication in primary tuberculous pleuritis and empyema with a study of functional recovery. J Thorac Surg 1956;32:178–89.
17. Deslauriers J, Perrault LP. Fibrothorax and decortication. In: Pearson FG, Deslauriers J, Hiebert CA, McKneally MF, Ginsberg RJ, Urschel HC, editors. Thoracic Surgery. New York: Churchill Livingstone; 1995. p. 1265–80.

Plevral Ampiyemlerde Dekortikasyon Operasyonunun Hastanın Solunum Fonksiyonları Üzerine Etkisi

Amaç: Visseral ve paryetal plevra arasındaki anatomik boşluktaki inflamatuar süreç sonrası meydana gelen pürülan sıvıya plevral ampiyem adı verilir. Tedavi edilmediği takdirde yüksek mortalite ve morbiditeye sahiptir. Çalışmamızın amacı kronik plevral ampiyem olarak adlandırılan son fazda etkin tedavi yöntemi olan dekortikasyon operasyonu öncesi ve sonrası solunum fonksiyonlarını spirometrik olarak değerlendirmektir.

Gereç ve Yöntem: Çalışmaya alınma ve dışlama kriterlerine göre değerlendirilen hastaların özellikleri retrospektif olarak değerlendirildi. Ameliyat öncesi 1 hafta içinde ve ameliyat sonrası 6. ayda yapılan spirometrik testle FEV1, FVC, %FEV1/FVC değerleri ölçülerek karşılaştırıldı.

Bulgular: Hastalarımızda dekortikasyon ameliyatı sonrası spirometrik değerlerinde belirgin bir düzelme tespit edildi. Ameliyat öncesi FVC değeri 2.33±0.71 (L), FEV1 değeri 1.91±0.56 (L), % FEV1/FVC değeri %82.77±8.50 iken bu değerler sırası ile 2.64±0.65 (L) (p=0.000), 2.28±0.57 (L) (p=0.000), % %86.52±7.47'ye (p=0.014) yükseldi. Ameliyat öncesi ve sonrası FVC, FEV1, %FEV1/FVC değişim ise yüzde olarak değerlendirildiğinde sırasıyla %13.3, %19.3, %4.53 olarak değerlendirildi. Bu sonuçlar istatiksel olarak FVC, FEV1 için oldukça anlamlıyken FEV1/FVC için anlamlı olarak bulundu. Spirometrik olarak değerlendirildiğinde (FVC, FEV1, %FEV1/FVC) ameliyat sonrası belirgin olarak artmaktadır.

Sonuç: Plevral ampiyem nedeniyle dekortikasyon operasyonu uygulanan hastaların postoperatif solunum fonksiyon testlerinde anlamlı derecede artış olduğu tespit edilmiştir. Çalışmamızın sonuçları, mevcut literatürle uyumludur. Bu nedenle uygun olgularda evre III plevral ampiyemlerin etkin tedavi seçeneğinin dekortikasyon olduğu kanaatindeyiz.

Anahtar Sözcükler: Akciğer fonksiyon testi; ampiyem; dekortikasyon.