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Original Article

Change in Pulmonary Function Following Decortication for Chronic Pleural Empyema

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Abstract

OBJECTIVES: Chronic empyema is the final stage of the triphasic pathogenesis of empyema that is characterized by fibrin deposits in both pleural surfaces, leading to the formation of a thickened pleural peel. This restricts the lung movements, giving rise to a trapped lung and impairment of pulmonary function. The aim of this study was to determine the change in pulmonary function following decortication for chronic empyema.

MATERIALS AND METHODS: A total of 35 patients with chronic pleural empyema who underwent decortication via a posterolateral thoracotomy between July 2016 and July 2017 were reviewed and followed-up for 6±3 months after surgery. All patients underwent a pulmonary function test using spirometry before and after surgery. Pre-operation spirometry values [mean forced expiratory volume in 1s (FEV_1) and mean forced vital capacity (FVC)] were compared with the post-operation data obtained during follow-up and the change was quantified by statistical analysis.

RESULTS: FEV_1 was 70.51% before surgery vs. 83.43% after surgery ($p<0.001$). FVC was 69.74% before surgery vs. 85.40% after surgery ($p<0.001$). There was no influence of bacteriology, side of occurrence of the lesion, smoking habit, or diabetes mellitus present before the operation on the patients' lung function ($p>0.01$).

CONCLUSION: Decortication and pleurectomy via a posterolateral thoracotomy resulted in significant clinico-functional improvement in patients with chronic empyema, regardless of the bacteriology, side of occurrence of the lesion, smoking habit, or diabetic status of the patient.

KEYWORDS: Pleural empyema, Decortication, empyemectomy, pulmonary function, spirometry

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INTRODUCTION

Empyema thoracis is defined as a purulent pleural effusion, i.e., the presence of pus in the pleural space [1]. Pleural empyema most commonly occurs as a complication of bacterial pneumonia. Alcohol abuse, diabetes mellitus, gastro-esophageal reflux disease, and intravenous drug abuse are the major risk factors that lead to severe bacterial pneumonia that becomes complicated with parapneumonic empyema. Microaspiration and poor oral hygiene also predispose to anaerobic bacterial infections, which eventually lead to empyema [2]. The other causes of pleural infection that are unrelated to bacterial pneumonia are mainly iatrogenic in nature, including thoracic (20%) and upper gastrointestinal surgery, esophageal perforation, and trauma (5%) [3].

Diagnosing parapneumonic effusion at the right time and commencing prompt treatment with antimicrobial drugs is crucial to prevent complications from this infection. Mismanagement of empyema leads to progression of the disease process into an exudative phase, a fibrinopurulent phase, and finally to an organized chronic phase. Since many causes of empyema are indolent, it presents frankly to a physician only after it has progressed to the fibro-purulent or the organized stage. Empyema that lasts 4 weeks and beyond is classified as chronic empyema [4]. In this chronic stage, the pleural cavity is surrounded by a cortex and effusion becomes organized. Fibroblasts deposit collagen over this organized clotted pleural fluid, leading to formation of an inelastic membrane also known as "the peel." This structure exerts a restrictive effect on the lung parenchyma, leading to a condition known as "trapped lung." The peel encapsulates the lung completely and prevents drug penetration, resulting in failure of medical management and development of acquired drug resistance.

Chronic empyema thoracis remains a serious thoracic disease with challenging management strategies. The success of various management strategies depends partly on the stage of empyema presentation. In spite of the availability and

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frequent use of techniques such as therapeutic pleural aspiration, intrapleural thrombolysis, underwater seal drainage, and open surgical drainage with rib resection previously, the condition remained frequently fatal. Although video-assisted thoracoscopic surgery (VATS) is a better novel technique to treat empyema, its efficacy in chronic empyema is questionable as the thick pleural peel or cortex hinders perfect clearance. The treatment options should aim at complete debridement so as to achieve full lung re-expansion without atelectasis, air leaks, or residual spaces. Further, if the underlying lung parenchyma is not healthy, it is recommended that the procedure be converted to an open lung resection surgery. Hence, at the chronic organized empyema stage, the standard treatment option is only empyemectomy via open thoracotomy and decortication, as it has the advantage of draining the purulent effusion adequately and completely, freeing the lung from loculations and re-expanding the lung to fill the pleural space [5-7].

The outcome of thoracotomy and decortication is better, with success rates of up to 95%, but with significant associated complications [8,9]. The use of modern antibiotics and advancements in perioperative care has made the mortality associated with the procedure almost negligible. Although it is a proven fact that decortication via open thoracotomy is curative in chronic infectious pleural disease, the long-term pulmonary function outcomes have been poorly investigated. Only a handful of studies are available so far that address the functional outcome in patients undergoing decortication via open thoracotomy [10-13].

This study aims to determine the functional outcome in patients undergoing decortication via open thoracotomy for chronic empyema thoracis by comparing various parameters, such as bacteriology, side of occurrence of the lesion, and presence of co-morbidities.

MAIN POINTS

- In the chronic phase of empyema, the pleurae become a thick peel which exerts restrictive effect on the lung parenchyma.
- Decortication via open thoracotomy, rather than VATS is the best treatment option at this phase as it is more effective in giving complete debridement.
- Spirometry parameters have shown significant improvement following surgery. FEV1 and FVC were 70.51% and 69.74% before surgery vs. 83.43% and 85.40% respectively, after surgery ($p<0.001$).
- Lung function improved in both tuberculous and non tuberculous patients. Although, the improvement in pulmonary function that is measured by calculating the difference between preoperative and postoperative values is slightly higher for tuberculous patients, these differences were not statistically significant.
- The side of occurrence of the lesion, smoking habit, or presence of co-morbidities does not affect the improvement of lung function.

MATERIALS AND METHODS

This descriptive and retrospective study was conducted in a tertiary-level hospital attached to a medical college. This study was approved by the scientific and ethics committee of Mysore medical college and research institute. The in-patient hospital records of all the chronic empyema patients who were subjected to decortication via open thoracotomy between July 2016 and July 2017 were reviewed retrospectively.

The diagnosis of empyema was made if either one of the following criteria were present: (1) drainage of purulent pleural fluid, (2) presence of biochemical parameters of empyema, such as pH of <7.2 and lactate dehydrogenase level of >1000 IU/L, (3) a positive bacterial pleural fluid gram stain or culture. Chronic empyema was defined according to the American Thoracic Society's staging system, where stage III empyema corresponds to chronic empyema, i.e., the organizing stage [14]. This diagnosis was supported by a duration of illness that was more than 15 days before definitive treatment was administered and by radiographic findings of entrapped lung due to pleural thickening [15].

Our study group consisted of empyema patients who underwent decortication via open thoracotomy with none of the exclusion parameters mentioned below. Patients who were not willing to give written informed consent, those with contraindications for spirometry, and those with unavailable preoperative spirometry data were excluded from the study. Even though tuberculosis patients were included in the study, those with parenchymal lesions as seen on X-ray or with a sputum smear positive for acid fast bacilli were excluded. Only exclusive pleural tuberculosis patients diagnosed using pleural fluid analysis or those exhibiting histopathological evidence of tuberculosis in the post-decortication specimen were selected to participate in the study. Prior administration of anti-tuberculosis chemotherapy was not a criterion for exclusion. Patients who had a prior history of chest tube insertion were included in the study, provided they satisfied the above criteria. On the other hand, patients who had undergone lung resection along with decortication were not included in the study.

Out of the 40 patients who underwent surgery, only 35 patients met the inclusion criteria. Patients were reassessed in their routine follow-up or when they visited the hospital at the physician's invitation to join this study. The postoperative evaluation was done at 6±3 months after surgery. Informed consent was obtained from all patients who agreed to join the study. The patients were evaluated using spirometry with the MIR Spirobank II (Portable multifunction and multifunction spirometer, MIR Medical International Research, Rome, Italy) and were interviewed regarding their general respiratory condition.

Preoperative spirometry values obtained from case sheets were compared with the postoperative data obtained during the follow-up, and the change was quantified by statistical analysis.

Statistical Analysis

Descriptive statistical analysis was expressed in terms of frequency, mean, and standard deviation. The frequencies for

categorical variables were compared using the Pearson Chi-square test. Continuous variables were compared using the t-test and ANOVA. A p-value of less than 0.001 was considered significant. Statistical analysis was done by the Statistical Package for Social Sciences version 16 (SPSS Inc.; Chicago, IL, USA) software.

RESULTS

Demographics Analysis

This study included 35 patients, with 31 men and 4 women. The patients' ages ranged from 17-65 years, with a mean age of 38.52±12.36 years. Nineteen patients (54.3%) had empyema on the right side and 16 (45.7%) presented with empyema on the left. Twenty (57.1%) patients were smokers, 7 (20%) had diabetes mellitus, 6 (17.1%) had anemia, and 17 (37.1%) had leucocytosis. The most common clinical findings prior to the surgery were chest pain (29 patients, 82.85%) and fever (27patients, 77.14%). Thirteen patients (37.14%) had a history of dyspnea during exercise. The mean time between the onset of acute illness to the time of decortication was 6.71±4.75 weeks. There was a history of ICD insertion in 9 patients (25.7%) before surgery.

Radiological grading of empyema was done in a manner similar to that of pleural effusion (Figure 1). Five patients (14.28%) had mild empyema (amount of purulent effusion does not exceed the 4th rib in the chest x-ray), 23 patients (65.71%) had moderate empyema (purulent effusion located between the 2th and 4th rib), and 7 patients (20%) had massive empyema (purulent effusion exceeding the 2nd rib).

The mean FEV_1 and FVC values improved significantly during the follow-up period, as shown in the Figures 2 and 3. FEV_1 was 70.51% before surgery vs. 83.43% after surgery

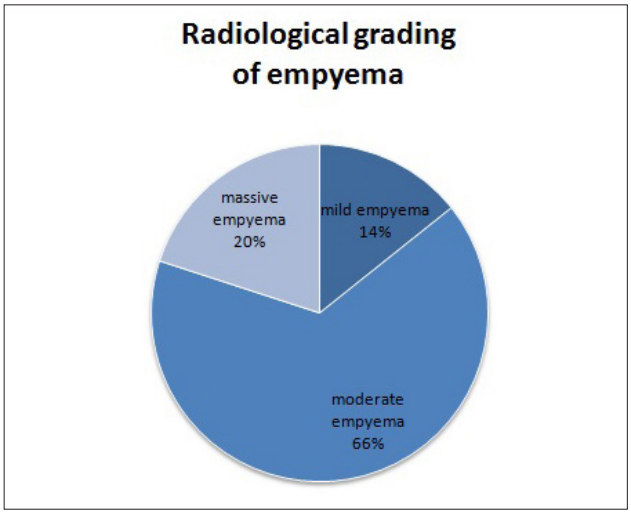

Figure 1. Radiological grading of empyema

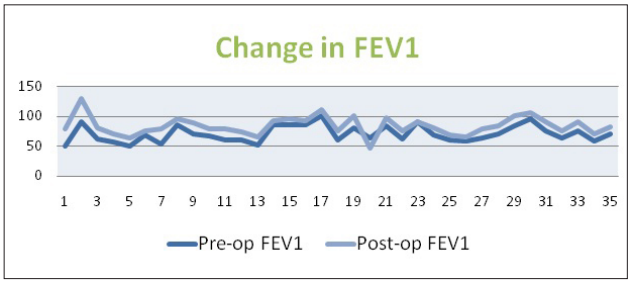

Figure 2. Graph showing the change in FEV_1 before and after surgery
FEV_1: forced expiratory volume in the 1st second

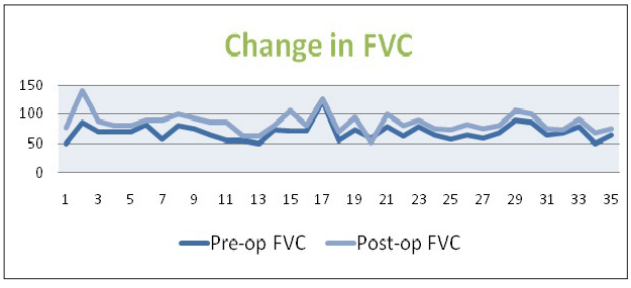

Figure 3. Graph showing the change in FVC before and after surgery
FVC: forced vital capacity

Table 1. Change in spirometric parameters before and after decortication

Parameter	Before decortication	After decortication	p
FEV_1	70.51	83.42	<0.001
FVC	69.74	85.40	<0.001
FEV_1 (TB)	69.19	83.52	<0.001
FVC (TB)	70.05	86.76	<0.001
FEV_1 (Non-TB)	72.5	83.42	<0.001
FVC (Non-TB)	69.28	82.78	<0.001

FEV_1: forced expiratory volume in the first second (expressed as mean); FVC: forced vital capacity (expressed as mean); TB: tuberculosis

Table 2. Comparison of mean change in pulmonary function in tuberculous and non-tuberculous patients

Pulmonary function	Tuberculous patients	Non-tuberculous patients	T-test value	p
Mean change in FEV_1	14.24	10.93	1.141	0.262
Mean change in FVC	17.10	13.50	0.969	0.339

FEV_1: forced expiratory volume in the first second; FVC–forced vital capacity; expressed as mean; T- student's t-test; p- paired t-test

Table 3. Comparison of improvements after right- and left-sided decortications

Pulmonary function	Right side decortications	Left-side decortications	T-test value	p
Mean change in FEV_1	13.16	12.63	0.183	0.856
Mean change in FVC	15.84	15.44	0.109	0.914

FEV_1: forced expiratory volume in the first second; FVC: forced vital capacity (expressed as mean); T:- student's t-test; p: paired t-test

Table 4. Comparison of the mean difference in FEV_1 among various groups

Variable		Mean FEV_1 difference	T-test value	p
Smoking habit	Smokers	12.55	0.291	0.773
	Non-smokers	13.40		
Diabetes Mellitus	Diabetic	10.86	0.715	0.479
	Non-diabetic	13.43		
Leucocytosis	Leucocytosis	12.54	0.200	0.843
	No leucocytosis	13.14		
Anemia	Anemic	16.83	1.260	0.217
	Not anemic	12.10		

FEV_1: forced expiratory volume in the first second; T: student's t-test; p: paired t-test

Table 5. Comparison of the mean difference in FVC among various groups

Variable		Mean FVC difference	T-test value	p
Smoking habit	Smokers	14.95	0.444	0.660
	Non-smokers	16.60		
Diabetes Mellitus	Diabetic	12.86	0.776	0.449
	Non-diabetic	16.36		
Leucocytosis	Leucocytosis	17.69	0.856	0.397
	No leucocytosis	14.45		
Anemia	Anemic	22.17	1.674	0.104
	Not anemic	14.31		

FVC: forced vital capacity (expressed as mean); T: student's t-test; p: paired t-test

($p<0.001$). FVC was 69.74% before surgery vs. 85.40% after surgery ($p<0.001$). One patient showed a mild decrease in FVC due to post-thoracotomy empyema.

Patients were classified into two groups based on etiology: 21 patients (60%) in Group A (tuberculous) and 14 patients (40%) in Group B (non-tuberculous). The mean FEV_1 and FVC values before and after surgery were compared between tuberculous and non-tuberculous patients, which showed significant improvement. All the above findings have been summarized in Table 1.

After decortication in tuberculous patients in the late period, the mean preoperative FEV_1 and FVC values improved to 14.24% and 17.10%, respectively. On the other hand, the FEV_1 and FVC values improved only to 10.93% and 13.50%, respectively, among non-tuberculous patients. Although, the improvement in pulmonary function that is measured by calculating the difference between preoperative and postoperative values is slightly higher for tuberculous patients, these differences were not statistically significant (Table 2). This improvement among tuberculous patients might be attributed to the contributory effect of anti-tuberculosis chemotherapy being administered to all patients who were diagnosed to have tuberculosis, as confirmed by histopathologically examining the decortication specimen.

Similarly, the mean change in pulmonary function was compared between the right and left sides. Although pulmonary functions showed slightly higher improvement in right-sided cases, however, these differences were not statistically significant (Table 3).

Analysis was done to check the influence of leucocytosis, concomitant diseases, smoking history, and anemia on functional recovery. There was no significant correlation between these factors and the analyzed functional parameters (Table 4, 5).

DISCUSSION

Chronic pleural empyema leads to passive atelectasis of the underlying compressed lung. Respiratory mechanics and ventilation become compromised due to the restrictive ventilatory defect and due (avoid capital D) to lesser oxygen penetration into the alveoli, the perfusion and gas exchange in the lung are also decreased. If this infection is uninterrupted, it may lead to chest wall deformity and total destruction of lung.

The diagnosis and treatment of pleural empyema in the early stage should be done to avoid complications leading to non-expansion of the lung and permanent restrictive lung defect [16]. Delayed perception of symptoms and diagnosis with late referral leads to empyema eventually progressing to the late chronic phase. The initial conservative management is not effective in such patients.

Decortication retains the functional capacity of the lung to a great extent. However, the extent to which the lung function can be restored has been a subject of controversy in the scientific community. There are studies that show contradictory findings that attribute to the differences in numbers and quality of the analyzed material. Patients with tuberculous etiology are prone to worse surgical outcome in terms of morbidity and mortality [17]. When tuberculosis is the etiology, spirometry parameters will not show any improvement after decortication [18,19]. Based on their studies, Petro et al. [18] and Toomes et al. [19] concluded that the measured spirometry parameters did not improve after treatment. Their studies also pointed out that patients with a preoperative vital capacity decrease of more than 40% of their predicted value experience functional benefits. However, our study, which has 60% of the subjects with a tuberculous etiology, contradicts these findings by showing a significant improvement in the measured spirometry parameters. The mean preoperative FEV_1 and FVC values improved by approximately 14% and 17%, respectively, after late period decortication in tuberculous empyema patients in our study. Our study also contributed the information that bacteriologic etiology does not influence pulmonary function positively or negatively.

Numerous studies have documented the impact of decortication on pulmonary function [10-13]. Most patients have had significant increases in FVC and FEV_1 in all of these studies. Choi et al. [10] compared the preoperative and postoperative

spirometry parameters after classifying the patients into two groups based on the bacteriologic etiology. All the spirometry parameters improved significantly in both groups. However, no significance was shown in the rate of increase of parameters between the two groups. Gokce et al. [12] studied the pulmonary function of 50 patients who underwent open decortication for empyema and found a mean increase of approximately 18% in the spirometry parameters. A study done in India by Rai et al. [13] also showed a similar improvement.

Our study also revealed that there was a slightly higher improvement in PFTs after right-sided decortication, which may be due to the comparatively larger volume of the right lung. However, the rate of increase in the parameters between the right- and left-sided decortications were not statistically significant. Similarly, the influence of leucocytosis, concomitant diseases, smoking history, and anemia on functional recovery were analyzed and proven not significant.

The postoperative evaluation was conducted 6±3 months after the surgery to avoid potential adverse effects. Some authors did not observe a functional recovery of the lung during this period and neither did they observe the deterioration of spirometry [10].

There are some limitations to the study, which include the relatively low patient number and retrospective design. Selection bias is inevitable, since many patients who were taken for decortication could have been treated with VATS. The use of only FEV_1 and FVC as measures of pulmonary function is a limitation because no single spirometry parameter can explain the physiology of chronic empyema thoracis. Since spirometry itself is effort-related, an ineffective effort may give false values. The type of surgical approach is one of the important factors that may affect the outcome [20]. However, our study had an advantage that all the patients were operated upon by a single thoracic surgeon with a single technique, i.e., decortication via open thoracotomy.

To conclude, decortication and empymectomy via open thoracotomy result in significant clinico-functional improvement in patients with chronic empyema. The patient's bacteriologic status, side of occurrence of the lesion, smoking habit, or presence of co-morbidities do not affect the improvement of lung function.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Mysore Medical College and Research Institute (date: 12/01/2018).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - P.C., S.V.A.; Design - S.V.A.; Supervision - P.C.; Resources - P.C.; Materials - P.C.; Data Collection and/or Processing - S.V.A.; Analysis and/or Interpretation - S.V.A.; Literature Search - S.V.A.; Writing Manuscript - S.V.A.; Critical Review - P.C.

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REFERENCES

1. Light RW. Parapneumonic effusions and empyema. Proc Am Thorac Soc 2006;3:75-80. [CrossRef]
2. Brook I, Frazier EH. Aerobic and anaerobic microbiology of empyema. A retrospective review in two military hospitals. Chest 1993;103:1502-7. [CrossRef]
3. Ferguson AD, Prescott RJ, Selkon JB, et al. The clinical course and management of thoracic empyema. QJM 1996;89:285-9. [CrossRef]
4. Molnar TF. Current surgical treatment of thoracic empyema in adults. Eur J Cardiothorac Surg 2007;32:422-30. [CrossRef]
5. Alegre RA, Garisto GD, Zobede S. Open thoracotomy and decortication for chronic empyema. Clinics 2008;63:789-93. [CrossRef]
6. Thourani VH, Brady KM, Mansour K, et al. Evaluation of treatment modalities for thoracic empyema: cost effective analysis. Ann Thoracic Surg 1998;66:1121-7. [CrossRef]
7. Soraino T, Alegre J, Aleman C, et al. Factors influencing the hospital stay in patients with bacterial pleural effusion. Respiration 2005;72:587-93. [CrossRef]
8. LeMense GP, Strange C, Sahn SA. Empyema thoracis: Therapeutic management and outcome. Chest 1995;107:1532-7. [CrossRef]
9. Melloni G, Carretta A, Ciriaco P, et al. Decortication for chronic parapneumonic empyema: results of a prospective study. World J Surg 2004;28:488-93. [CrossRef]
10. Choi SS, Kim DJ, Kim KD, et al. Change in pulmonary function following empyemectomy and decortication in tuberculous and non-tuberculous chronic empyema thoracis. Yonsei Med J 2004;45:643-8. [CrossRef]
11. Rzyman W., Skokowski J., Romanowicz G, et al. Decortication in chronic pleural empyema-effect on lung function Eur J of Cardiothorac Surg 2002;21:502-7. [CrossRef]
12. Gokce M, Okur E, Baysungur V, et al. 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]
13. Rai SP, Kaul SK, Tripathi RK, et al. Decortication in chronic pleural empyema. Lung India 2006;23:100-2. [CrossRef]
14. Andrews NC, Parker EF, Shaw RR, et al. Management of Non-tuberculous empyema. Am Rev Respir Dis 1962;85:935-6.
15. LeMense GP, Strange C, Sahn SA. Empyema thoracic, therapeutic management and outcome. Chest 1995;107:1532-7. [CrossRef]
16. Thourani VH, Brady KM, Mansour K, et al. Evaluation of treatment modalities for thoracic empyema: cost effective analysis. Ann Thoracic Surg 1998;66:1121-7. [CrossRef]
17. Mouroux J, Maalouf J, Padovani B, et al. Surgical management of pleuropulmonary tuberculosis. J Thorac Cardiovasc Surg 1996;111:662-70. [CrossRef]
18. Petro W, Maassen W, Greschuchna D, et al. Regional and global lung function in unilateral fibrothorax after conservative therapy and decortication. Thorac Cardiovasc Surgeon 1982;30:137-41. [CrossRef]
19. Toomes H, Vogt-Moykopf I, Ahrendt J. Decortication of the lung. Thorac Cardiovasc Surg 1983;31:338-41. [CrossRef]
20. Nichkaode P, Agrawal R, Patel S. Thoracotomy and decortication in chronic empyema (fibrothorax), in the era of video assisted thoracic surgery. Int Surg J 2017;4:2741-5. [CrossRef]