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Chronic tuberculous empyema: relationships between preoperative CT findings and postoperative improvement measured by pulmonary function testing

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Tuberculosis; Empyema; Computed tomography (CT); Forced expiratory volume; Forced expiratory flow rate

AIMS: To evaluate whether preoperative computed tomography (CT) findings correlate with postoperative improvements in forced vital capacity (FVC) and forced expiratory volume during 1 s (FEV1) in persons who have undergone unilateral decortication because of unilateral chronic tuberculous empyema.

METHODS: A retrospective study was carried out of 67 individuals who had undergone decortication because of chronic tuberculous empyema between January 1996 and December 2000. Of these, 13 subjects who had had preoperative chest CT and preoperative and postoperative pulmonary function tests (PFTs) were included in the investigation. On preoperative CT, the degree of volume reduction of the affected side was compared with that of the contralateral normal lung. The relative volume of empyema was calculated by dividing the volume occupied by the empyema by the sum of the total volume of the ipsilateral lung and the empyema volume. The thicknesses of pleura and extrapleural fat in the involved hemithorax were measured by CT at their thickest points, and the degree of atelectasis adjacent to the empyema in the diseased lung was assessed and classified. These five CT parameters and the ages of the patients were compared with preoperative and postoperative FVC and FEV1 changes.

RESULTS: A significant negative correlation was found between FVC changes and the relative volume of the affected lung (FVC: $p=0.039$, RS $=-0.58$). FVC and FEV1 were found to be significantly and positively correlated with the relative volume of the empyema (FVC: $p=0.005$, RS $=0.72$; FEV1: $p=0.014$, RS $=0.66$) and the degree of atelectasis (FVC: $p=0.007$, RS $=0.71$; FEV1: $p=0.029$, RS $=0.60$) by Spearman's nonparametric correlation test. Other CT parameters and the ages of the patients were not found to be correlated with PFT changes.

CONCLUSION: The relative volume of the affected side, the relative volume of empyema and the degree of atelectasis can predict improvements in FVC and FEV1 after decortication in patients with chronic tuberculous empyema.

Introduction

Chronic empyema can be caused by *Mycobacterium tuberculosis*, anaerobic bacteria, *Staphylococcus aureus, Streptococcus pneumoniae*, and various

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other Gram-negative bacteria. In the evolution of empyema, different stages can be observed: exudative, fibropurulent and organizational. In the organizational stage of empyema, an ingrowth of fibroblasts occurs along the fibrin sheets lining the visceral and parietal pleura together with a progressive decrease in cellularity, and this membrane may either remain thin or in time become thick and dense.[1]

Tuberculous empyema should be managed in its acute exudative phase in order to avoid the development of chronic empyema, which carries a higher risk of morbidity and mortality.[2] If neither tube drainage nor adequate anti-tuberculous chemotherapy has been instituted before the exudative or the organizational stage of empyema, decortication of the diseased pleura is an optimal therapeutic method for restoring lung function.[3]

Computed tomography (CT) is a commonly used for the detection and differential diagnosis of pleural disease, and for the treatment planning and the postoperative follow-up of patients with chronic empyema.[4] Pulmonary function improvement has been described following the decortication of chronic pleural empyema (not performed exclusively for patients with tuberculous empyema).[5]

The purpose of our study was to evaluate whether preoperative CT findings correlate with postoperative forced vital capacity (FVC) or forced expiratory volume during 1 s (FEV1) in individuals who have undergone decortication because of chronic tuberculous empyema.

Materials and methods

We retrospectively reviewed 67 consecutive patients who had undergone decortication surgery between January 1996 and December 2000. Of these, 13 who had had preoperative chest CT (within 2 months before decortication) and postoperative pulmonary function tests (PFTs) (within 12 months after decortication), and whose tuberculous empyema had been confirmed, were included in the study. The indications for decortication surgery were inadequate pleural space obliteration by drainage or antibiotics or both, and absence of gross parenchymal destruction in the lung adjacent to the empyema sac. The diagnosis of tuberculous empyema was based on the histopathological findings of resected specimens. The 13 subjects were men aged from 20 to 67 years (median: 28 years).

This study was approved by the ethics committee on clinical investigations of Seoul National University Hospital College of Medicine, and informed consent was obtained from all patients and all control subjects.

CT was performed 2 months or less before decortication surgery (1 day to 2 months, mean: 13.3 days), at full inspiration after intravenously injecting 1.4 ml/kg non-ionic contrast medium (Ultravist 370, Schering, Berlin, Germany). We used a CT 9800 (GE Medical Systems, Milwaukee, WI) ($n=4$), a Genesis HiSpeed (GE Medical Systems, Milwaukee, WI) ($n=5$), and a Somatom Plus 4 (Siemens Medical Systems, Munich, Germany) ($n=15$). The scanning parameters were 120 kVp, 230 mAs and 5 to 10 mm collimation, with 5 to 10 mm reconstruction intervals from the lower neck to the lower pole of the kidney.

The CT images were reviewed by two experienced chest radiologists (J.G.I. and J.M.G.) independently, and final interpretations of discordant analyses were reached by consensus. Lung volume, empyema volume, extrapleural fat thickness, pleural thickness and the degree of atelectasis were determined (Table 1).

Areas of the lung (Fig. 1(a)) and empyema (Fig. 1(b)) were measured using a custom-made program developed on an IDL (Interactive Data Language, Research Systems Inc., USA) platform at three levels (aortic arch, left atrium and liver dome) and averaged to reflect lung volume. We excluded pleural thickness and extrapleural fat from the measurement of lung and empyema volumes, retrospectively. The relative volume of the affected lung (%) was calculated by dividing the volume of the affected lung by the volume of the contralateral normal lung, and correcting this using the left/right lung volume ratio of healthy individuals in the same age group ($n=6$ for those in the second decade and $n=10$ for those in the third, to seventh decades) (Table 2). The average ratio of right lung volume to left lung volume in the normal group ranged from 1.1 to 1.41. Correction was performed by multiplying the calculated relative volume of the affected side lung by the age group average left/right correction value. The relative volume of empyema was calculated by measuring the volume of empyema divided by the sum of the volume of empyema and the volume of the ipsilateral lung. The thicknesses of pleura and extrapleural fat in the diseased hemithorax were measured by CT at their thickest points, and the degree of atelectasis in the lung adjacent to the empyema was graded using a 6-point scale where 0 = none, 1 = linear, 2 = subsegmental, 3 = segmental, 4 = more than segmental but less than lobar, and 5 = lobar.