The Outcome of Volume Reduction Surgery According to the Underlying Type of Emphysema

KAZURO SUGI1, YOSHIKAZU KANEDA2, TOMOYUKI MURAKAMI1, and KENSUKE ESATO2

1 Department of Clinical Research, Sanyo National Hospital, 685 Higashikiwa, Ube, Yamaguchi 755-0241, Japan
2 First Department of Surgery, Yamaguchi University School of Medicine, 1-1-1 Minamikogushi, Ube, Yamaguchi 755-8505, Japan

Abstract Lung volume reduction surgery (VRS) is widely performed to improve symptoms in patients with severe pulmonary emphysema; however, it remains unclear whether or not the underlying type of emphysema affects the surgical results. A total of 58 patients with advanced symptomatic emphysema underwent thoracoscopic VRS of emphysematous lung tissue. The resected lung tissue was examined microscopically, and the patients were classified into two groups according to the predominant pathological findings, as having either centrilobular-type or panacinar-type emphysema. A predominant pathological type was identified in only 34 patients (59%), 19 of whom had centrilobular-type emphysema and 15, panacinar-type emphysema. Patients with predominately panacinar emphysema had more compromised total lung capacity and residual volume than those with centrilobular emphysema. Significant improvements in forced expiratory volume in 1s were evident 3 months after surgery in the group with centrilobular emphysema (+515 ± 141ml) compared with that in the group with panacinar emphysema (+109 ± 40ml, P = 0.03). The results of lung VRS were found to depend on the underlying type of emphysema, as the benefits of surgery for panacinar emphysema were less marked than those for centrilobular emphysema.

Key words Centrilobular · Panacinar · Pulmonary emphysema · Pathology · Volume reduction surgery

Introduction

Lung volume reduction surgery (VRS) is one of the most successful forms of treatment for patients with severe pulmonary emphysema.1,2 As the early results have been encouraging, this procedure is now being performed in many centers; however, a number of problems associated with this new treatment remain unsolved, such as patient selection, surgical technique, long-term results, and prognosis. This study was conducted to determine whether the underlying type of emphysema influences the early results of VRS.

Patients and Methods

The criteria for inclusion in the present study consisted of: a diagnosis of end-stage emphysema; disabling dyspnea at an altitude of less than 500m; a forced expiratory volume percentage in 1s (FEV1%) of <55%; and hyperinflated lungs. The criteria for exclusion included: tobacco smoking within 3 months of surgery; unstable coronary artery disease; pulmonary hypertension, defined as a pulmonary arterial resistance >400 dyne s cm⁻²/m²; and the inability to participate in rehabilitation. Once a patient was thought to have reached his maximum level of rehabilitation, final preoperative testing was conducted and elective surgery was scheduled. All patients were reevaluated 3 months after surgery. A total of 58 patients who underwent video-assisted thoracoscopic lung reduction between November 1994 and May 1997 were included in this study. All of the patients were men with a mean age of 69.8 ± 0.9 years, whose emphysema had been caused by cigarette smoking. None of the patients had α₁-antitrypsin deficiency.

Lung reduction using video-assisted thoracoscopic surgery (VATS) was performed unilaterally. The choice of which lung to resect was based on the severity of retention, as assessed by ¹³³Xe and ⁹⁹ᵐTc single photon emission computed tomography (SPECT) images. Thus, the right lung was resected in 19 patients and the left lung was resected in 15 patients.3 Once the decision
had been made about which lung to resect, the areas of lung excision were determined by identifying the regions of air retention and reduced perfusion by SPECT images. The nonventilation and no-flow areas, represented by simultaneous defects on $^{133}$Xe distribution and the $^{99m}$Tc image, were resected. The destroyed areas, represented by prolonged air trapping in the Xe gas washout images and reduced perfusion in the $^{99m}$Tc SPECT images, were also resected. Our surgical procedure was similar to that described by Naunheim et al. Briefly, patients were placed in the lateral decubitus position and an average of four trocar port sites were established. The “target” area of lung was identified and excised using an endoscopic stapling device (EZ60 Endostapler; Ethicon EndoSurgery, Cincinnati, OH, USA). Bovine pericardium was routinely used to buttress the staple line. Chest tubes were then placed in the apex and along the diaphragm, which were connected to a chest drainage system at 5 cmH$_2$O of suction. No complications, except for persistent air leakage, developed in any of the patients.

The resected lung tissue was inflated and fixed by an intraparenchymal infusion of 10% of formalin for at least 24 h, with 20 cmH$_2$O pressure, maintained by 20 cm elevation of the formalin bottle from the lung tissue. At least five slices of lung tissue, or more if possible, were cut, and stained with hematoxylin–eosin. This study was carried out retrospectively, and the pathologist was uninformed about the patients’s prognosis. The emphysema was classified by microscopic examination (Fig. 1). It was defined as the centrilobular type if the predominant type of emphysema was centrilobular, with air-space enlargement around the respiratory bronchioles, and the parenchymal tissue surrounding the emphysema lesions appeared relatively normal; or as the panacinar type if the predominant type was panacinar, with air-space enlargement affecting the whole acinar unit, and if muscular and fibrotic components were observed in the wall of the emphysematous spaces and in the partitions of emphysematous clusters. If the parenchymal destruction was so severe that a pathological diagnosis was not able to be made, the patients were excluded from the final evaluation.

Statistical analyses were performed with the $\chi^2$ test for categorical data and Student’s $t$-tests. A $P$ value of less than 0.05 was considered significant.

**Results**

The predominant type of emphysema was able to be established in only 34 (58.6%) of the 58 patients. In the other 24 patients the parenchyma had been destroyed to such an extent that the predominant pathological classification was impossible to identify. The predominant location of the centrilobular type of emphysema was the upper lobe, seen in ten patients (52.6%), while seven (36.8%) had lower lobe predominant emphysema, and the remaining two (10.5%) had involvement of all lobes. In the patients with the panacinar type of emphysema, SPECT images revealed inhomogeneous emphysematous change, but these changes extended to the whole lung in seven patients (46.7%), accounting for almost half of the subjects. Predominantly upper lobe emphysema was found in three of these patients (20%), and predominantly lower lobe emphysema was found in five patients (33.3%). The distribution of predominant emphysema was as follows:

- **Centrilobular Type**
  - Upper lobe: 10 patients (52.6%)
  - Lower lobe: 7 patients (36.8%)
  - All lobes: 2 patients (10.5%)

- **Panacinar Type**
  - Upper lobe: 3 patients (20%)
  - Lower lobe: 5 patients (33.3%)
  - All lobes: 7 patients (46.7%)

**Fig. 1.** a Centrilobular-type emphysema, defined by air-space enlargement around the respiratory bronchioles with relatively normal appearing parenchymal tissue surrounding the emphysema lesions (×400). b Panacinar-type emphysema, defined by the muscular and fibrotic component in the wall of the emphysematous spaces and in the partitions of the emphysematous clusters (×400)