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Lung Volume Reduction Surgery in Patients with Heterogenous Emphysema: Selecting Perspective

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Keywords: Lung volume reduction surgery (LVRS); Heterogenous emphysema; Selecting patient

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Abstract

BACKGROUND: Lung volume reduction surgery (LVRS) was introduced to alleviate clinical conditions in selected patients with heterogenous emphysema. Clarifying the most suitable patients for LVRS remained unclear.

AIM: This study was undertaken to specifically analyze the preoperative factor affecting to LVRS.

METHODS: The prospective study was conducted at 103 Military Hospital between July 2014 and April 2016. Severe heterogenous emphysema patients were selected to participate in the study. The information, spirometry, and body plethysmographic pulmonary function tests in 31 patients who underwent LVRS were compared with postoperative outcomes (changing in FEV1 and CAT scale).

RESULTS: Of the 31 patients, there was statistically significant difference in the outcome of functional capacity, lung function between two groups (FEV1 ≤ 50% and > 50%) (∆FEV1: 22.46 vs 18.32%; p = 0.042. ∆CAT: 6.85 vs 5.07; p = 0.048). Changes of the FEV1 and CAT scale were no statistically significant differences in three groups residual volume. Patients with total lung capacity < 140% had more improved than others (∆FEV1: 23.81 vs 15.1%; p = 0.031).

CONCLUSION: Preoperative spirometry and body plethysmographic pulmonary function tests were useful measures to selected severe heterogenous emphysema patients for LVRS. Patients with FEV1 ≤ 50%, TLC in the range of 100-140% should be selected.

Introduction

Emphysema is an incurable with high prevalence in adults worldwide [1]. It has been treated according to the guideline of GOLD [1]. In severe emphysema, treatment included lung volume reduction (LVR) therapy in accordance with medical treatment to maximize clinically meaningful benefits [2]. Three common LVR therapies were surgery, endobronchial valve, endobronchial coil but each therapy was considered to feasible in selected patients [2]. LVR coil treatment for bilateral lung emphysema resulted in good safety and sustained outcomes with significant clinical improvements [3]. Endobronchial valves for intact interlobar fissures in emphysema improved significantly in lung function [4]. In severe emphysema with selected cases, LVRS has been showed good outcomes [5]. It was more widely used in the treatment of emphysema [6], [7] with selection criteria depended on characteristics of diseases and patients. In most series, LVRS was chosen for patients who had heterogenous emphysema with upper lobes occupying almost that present in about 25 percent of moderate-to-severe patients [8]. Thus, the benefit of LVRS did not generate to all patients. The reason behind this is that LVRS is suitable for selecting patients. It showed effective in patients with bilateral upper lobe heterogeneous emphysema but did not use for the

arbitrary patient [9]. The NETT study pointed out the condition that benefits for LVRS were heterogenous disease, low baseline exercise capacity, and upper lobe predominance [5]. Beyond the NETT selection criteria, more patients with different conditions also can be suitable for LVRS [10]. To get successful outcomes, patient selection and preoperation care were crucial [11].

Clarifying the most suitable patients for LVRS remained unclear. This study, therefore, was undertaken to specifically analyze the preoperative factor affecting to this surgery. This contributed to further refine the selection criteria when LVRS is performed for patients with severe heterogeneous emphysema.

Materials and Method

Patients

This prospective study was conducted at 103 Military Hospital between July 2014 and April 2016. Severe emphysema patients were selected to participate in the study. Patients had inclusion and no exclusion criteria underwent LVRS. Selecting criteria for LVRS showed in Table 1. Indications for LVRS included clinical symptom (severe dyspnea), spirometry (airflow obstruction), and image of emphysema (on chest radiography and computed tomographic (CT) scanning). Any history of childhood asthma/atopy, bronchiectasis, inhalation injury or drug-caused bronchiolitis was excluded from the study.

Table 1: Selecting criteria for LVRS

Inclusion criteria
Age 40-80 years
Severe, heterogeneous emphysema, at CT
Forced expiratory volume in one second ≤ 60% but > 20%
Residual volume ≥ 150%
Total lung capacity ≥ 100%
Resting room PaO2 > 45 mmHg
Quit smoking since at least 4 months

Evaluation before surgery

Six months before performing surgery, all patients stopped cigarettes and six-week before that, a pulmonary rehabilitation program for all patients was required. The final routine evaluation for surgery was managed without abnormal findings [12], [13], [14]. Patients had any contraindications to surgery at that time were excluded such as severe concurrent diseases, pleural scarring, pulmonary-artery hypertension or; using inappropriate glucocorticoids; and failure to complete the requirements above before surgery [5]. Dividing patients into two groups: group 1: 17 patients with FEV1 ≤ 50% before surgery and group 2: 14 patients with FEV1 > 50% before surgery.

Surgical Technique

Choosing a surgical technique depended on the condition of patients [15]. After placing lateral decubitus position, general anesthesia was used with provision for single-lung ventilation. Unilateral thoracoscopic surgery was performed in 6 patients and video-assisted thoracoscopic surgery (VATS) was performed in 25 patients to reduce lung volume. Approximately about 30% of the lung (estimating 30-40 grams) was resected (Figure 1).

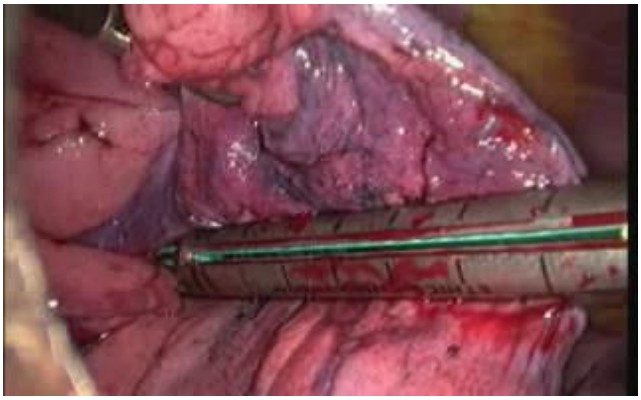

Figure 1: Lung resection in lung volume reduction surgery (LVRS)

Follow-up

Three months after surgery, change FEV1 and CAT scale were compared to evaluate the valuable index for LVRS.

Statistical Analysis

Using SPSS ver. 20.0 software (IBM Corporation, Armonk, NY, USA) to analyze. Descriptive analysis was presented as a means ± standard deviations. Using Student's paired t-test to compare with p-value that considered statistically significant was < 0.05.

Results

Patients' characteristics

Thirty-one patients participated in and completed the study. There were no hospital deaths in all group, no patient died three months after surgery. Preoperative patient's characteristics showed in Table 2. Functional capacity was assessed by the COPD Assessment Test scale (CAT). Spirometry demonstrated FEV1, TLC, and RV. All FEV1 values were less than normal with the mean was 49.46 percent and the lowest value was 23 percent. TLC was only minimally elevated with the value was more than 100 percent. Whereas RV was significantly elevated with patients, the value was more than 150

percent in all patients and the maximum value was 479 percent.

Table 2: Preoperative characteristics

Characteristics	Value
Age (years)	62.13 ± 5.77
Gender (M/F)	31 / 0
CAT scale	18.42 ± 5.57
Forced expiratory volume in one second (FEV1)	
Mean (%)	49.46 ± 12.22
≤ 50%	17
> 50%	14
Geansler index (%)	58.0 ± 11.93
Total lung capacity (TLC)	
Mean	137.29 ± 23.83
Range	106-227
Residual volume (RV)	
Mean	219.25 ± 72.14
Range	153-479

Postoperative outcome

After LVRS, FEV1 significantly increased as a whole. Two groups were compared before surgery and three months after surgery. Detail information showed in Table 3. Changes in FEV1 and CAT scale in group 1 was 22.46% and 6.85. Group 1 had more improved than group 2.

Table 3: Comparison between two groups

Variable	ΔFEV1 *Mean (95% CI)*	ΔCAT *Mean (95% CI)*
FEV1		
≤ 50%	22.46 (7.75 – 37.16)	6.85 (5.84 – 7.4)
> 50%	18.32 (7.55 – 29.10)	5.07 (3.36 – 6.77)
Significance	*p = 0.042*	*p = 0.048*
RV		
150-200%	19.81 (7.33 – 32.28)	5.3 (3.81 – 6.79)
200-250%	29.75 (8.87 – 50.64)	7 (5.11 – 8.88)
> 250%	16.37 (9.90 – 42.73)	6.4 (3.97 – 8.82)
Significance	*p = 0.123*	*p = 0.19*
TLC		
100 – 140%	23.81 (10.21 – 37.41)	5.76 (4.45 – 7.06)
> 140%	15.10 (7.23 – 22.97)	6.27 (4.68 – 7.86)
Significance	*p = 0.031*	*p = 0.6*

Patient with a preoperative RV less than 200%, the mean of change FEV1 was 19.81% and change of CAT scale was 5.3. The FEV1 increased 29.75% for patients with RV from 200 to 250% compared with 16.37% for patients with RV greater than 250% ($p > 0.05$). Preoperative, 10 patients had TLC than 100% and less than 140% of the predicted value. Their postoperative mean FEV1 increased by 23.81% compared with 15.10% changes in patients with preoperative TLC greater than 140% of the predicted value.

Discussion

LVRS showed more benefits in the patient with severe heterogeneous emphysema in terms of many clinical outcomes [16]. One of the key factors to achieve these benefits is selecting the right candidates for surgery. It includes general risk and the emphysema characteristics regarding morphology and function. From morphological perspectives, the diseased regions in emphysema were detected by computed tomography densitometry [17]. It helped to target and treat with segmental approach that was promise method to improve efficacy and safety outcomes.[18] But from functional perspectives, many questions for the selection of ideal candidates for LVRS remained unclear [19].

The core concept of LVRS is resecting non-functional areas to allow improving functional areas [20]. This is why it does not benefit in the case of patients who had airway obstruction. In our study, we reasoned that spirometry and body plethysmographic pulmonary function tests would be valuable factors in selecting patients for LVRS. In patients with highly airway resistance, the expiratory flow seems to not improving in response to LVRS [21], [22]. Vice versa, lung function improved when performing LVRS in patients with less airway resistance [23], [24], [25], [26]. In line with the lung function test, functional capacity assessed by CAT that presented the limitation of activity with moderate-to-severe level [27], [28]. It is valuable indicator to fully evaluate patients after LVRS.

In this study, the measures of clinical outcomes include changing in FEV1 and changing in CAT scale. After LVRS, the apparent improvement in FEV1 and CAT scale has improved quality of life, reduced dyspnea, and increased physical activities. The improvement in clinical outcomes following LVRS best correlates with the activity of respiratory muscle. Patients with FEV1 ≤ 50% have relatively severe obstruction. Meanwhile, patients with FEV1 > 50% of the degree of dyspnea and moderate obstruction, and the improvement was not as obvious as the FEV1 group under 50%. However, the patients who have too low FEV1 face a high risk of complications after surgery, especially those with FEV1 below 20% [29]. In addition, TLC is also a factor in recommending patients for LVRS. In our study, the results showed that TLC patients in the range of 100-140% given better postoperative results than patients with TLC above 140%. High TLC patients exhibit severe emphysema. With these patients, the lung parenchyma was less elastic, reducing perfusion, so LVRS recovery was also worse than that of the small TLC group. Our data showed that it was reasonable to perform LVRS on the patients with FEV1 ≤ 50 and TLC < 140 percent of the predicted value. These findings will optimize evaluating patients with heterogeneous emphysema who consider for LVRS.

In conclusion, preoperative spirometry and body plethysmographic pulmonary function tests were useful measures to selected severe heterogenous emphysema patients for LVRS. Patients with FEV1 ≤ 50%, TLC in the range of 100-140% should be selected.

Ethical approval

This study is approved by the ethics committee of 103 Military Hospital.

Informed consent

The consent and commitment were signed by the patients in the study.

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