

Systemic and regional pulmonary function after segmentectomy



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ABSTRACT

Objective: Segmentectomy includes numerous kinds of procedures that may result in decreased postoperative pulmonary function. This causes controversy regarding the functional advantage of segmentectomy over lobectomy. To clarify the difference between the procedures, systemic and regional pulmonary functions of the resected segments must be examined.

Methods: Pulmonary function tests and lung perfusion single-photon emission computed tomography (SPECT) were prospectively conducted before and after segmentectomy in 117 patients who were divided into groups based on resection of <2 segments ($n = 83$), ≥ 2 segments ($n = 20$), and left upper division (LUD) ($n = 14$). Left upper lobectomy ($n = 13$) was used as a control for the LUD group. Forced expiratory volume in 1 second (FEV_1) of segment and lobe were measured from a fusion image of SPECT and computed tomography.

Results: Percentage of postoperative/preoperative pulmonary function was the highest in the <2 segments group ($97\% \pm 10\%$), which was followed by the ≥ 2 segments group ($90\% \pm 9\%$), LUD group ($84\% \pm 7\%$), and left upper lobectomy group ($83\% \pm 7\%$), and the differences between the segmentectomy groups were significant ($P < .001-.03$), although there was no difference between the LUD and lobectomy groups. Whereas actual FEV_1 of preserved lobes were significantly lower than the predicted value in all segmentectomy groups ($P < .001$), the percentage of actual/predicted value in the LUD group ($43\% \pm 19\%$) was significantly lower than those in the <2 ($72\% \pm 23\%$) and ≥ 2 segments ($68\% \pm 30\%$) groups ($P < .001$ and $P = .02$, respectively).

Conclusions: Segmentectomy decreased the pulmonary function with increasing number of resected segments. LUD segmentectomy decreased both systemic and lobar function significantly due to not only large resection, but also marked depression of the preserved lobe, resulting in similar decrease as lobectomy. (J Thorac Cardiovasc Surg 2016;152:747-53)

Controversy remains regarding the superiority of pulmonary segmentectomy over lobectomy in preserving pulmonary function,¹⁻⁸ and the differences between reports may result from differences in resected segment volume. Because there are numerous types of segmentectomy with differing numbers of resected segments, postoperative pulmonary function would differ

according to the type. In particular, the left upper division (LUD) has a larger volume than the other segments, so resection seems more like an LUD lobectomy than a segmentectomy. In addition, the preserved lingular segment after LUD segmentectomy might not be able to function well because of its original small volume and destruction by surgical procedure. If the LUD segmentectomy would not differ in preserving pulmonary function from left upper lobectomy, it may partially cause

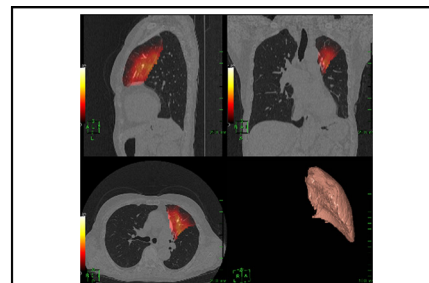
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Lung perfusion single-photon emission computed tomography/computed tomography image of lingular segment after left upper division segmentectomy.

Central Message

Segmentectomy decreased pulmonary function with increasing number of resected segments. LUD segmentectomy decreased the function equally as lobectomy.

Perspective

Differences of systemic and regional pulmonary function among segmentectomy were examined. Postoperative preserved function was the highest in the group undergoing resection of <2 segments, followed by the ≥ 2 segments group, and left upper division group. Left upper division segmentectomy decreased the function significantly due to large resection and marked depression of the preserved lobe, resulting in similar decrease as lobectomy.

See Editorial Commentary page 754.

Scanning this QR code will take you to a procedural video.



Abbreviations and Acronyms

- CT = computed tomography
- FEV₁ = forced expiratory volume in 1 second
- LUD = left upper division
- PFT = pulmonary function test
- RA = radioactivity
- SPECT = single-photon emission computed tomography

the claim that segmentectomy cannot contribute to preserving pulmonary function compared with lobectomy.

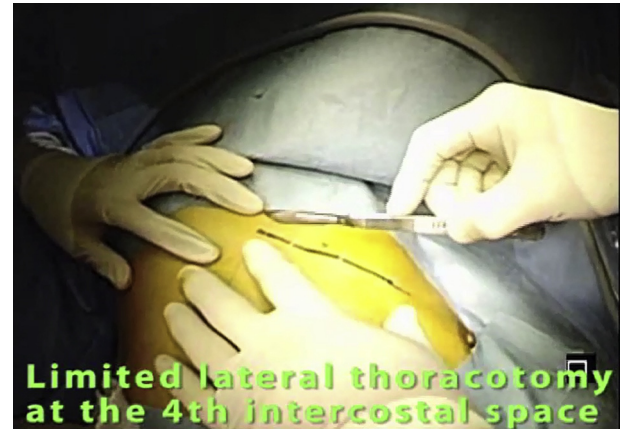
In addition, we also have to know the difference in postoperative pulmonary function in the resected segments. Although a resection of single segment is a popular procedure, the resection of >1 segment is often needed for tumors located beyond the border of a segment,⁹ which might result in a significant decrease of pulmonary function compared with the resection of a single segment. However, there have been no reports showing the difference in pulmonary function in resected segments. If the resection of multiple segments causes a significant decrease in postoperative pulmonary function compared with resection of a single segment, it should be taken into account while making decisions regarding segmentectomy and also for comparison studies of pulmonary function between segmentectomy and lobectomy.

To compare the preserved function among the segmentectomy procedures, we examined not only the systemic function measured by a routine pulmonary function test (PFT), but also the regional functions of lobes and segments measured by lung perfusion with single-photon emission computed tomography (SPECT).

MATERIALS AND METHODS

Patients

Between January 2013 and June 2015, a total of 143 patients underwent segmentectomy for lung cancer using previously reported techniques^{10,11} (see Video 1). Of these, 26 patients were excluded because they had not undergone both pre- and postoperative perfusion SPECT/computed tomography (CT) (n = 8) or they underwent additional resections for other lung lesions (n = 18). The remaining 117 patients underwent PFT and perfusion SPECT/CT before and >6 months (median, 7 months; range, 6-13 months) after segmentectomy (Table 1). Among these patients, resection of <2 segments was conducted in 83 patients, resection of ≥2 segments other than the LUD was conducted in 20 patients, and LUD segmentectomy was conducted in 14 patients. Basal segmentectomy was conducted in 1 patient in the ≥2 segments group. The mean number of resected subsegments in the <2 segments, ≥2 segments, and LUD groups were 2.3 ± 0.8, 4.6 ± 0.8, and 6 ± 0, respectively. As a control for the LUD group, 13 patients treated by left upper lobectomy were used (Table 1). No significant differences in age, sex, smoking history, or pulmonary function were evident among the groups, but mean tumor size in the LUD group (3.1 ± 1.5 cm) was significantly larger than that in the <2 segments (1.7 ± 0.6 cm; P < .001) and ≥2 segments groups (2.0 ± 0.7 cm; P = .008).



VIDEO 1. Segmentectomy of right S2 and S1a. Detailed techniques are explained in subtitles on each scene. Video available at: [http://www.jtcvsonline.org/article/S0022-5223\(16\)30497-4/addons](http://www.jtcvsonline.org/article/S0022-5223(16)30497-4/addons).

PFT

Vital capacity, forced vital capacity, and forced expiratory volume in 1 second (FEV₁) were measured using a dry rolling-seal spirometer (CHESTAC-9800DN; Chest, Tokyo, Japan). The percentage of postoperative function to preoperative function was measured from the PFT using the following formula:

$$[\text{Postoperative FEV}_1 / \text{Preoperative FEV}_1] \times 100\%$$

TABLE 1. Patient characteristics

	Number of resected segments			
	<2	≥2	LUD	LUL
Mean age, y	67 ± 10	72 ± 6	69 ± 6	68 ± 8
Sex				
Male	49 (59)	12 (60)	9 (64)	7 (54)
Female	34 (41)	8 (40)	5 (36)	6 (46)
Smoking				
Nonsmoker	40 (48)	7 (35)	7 (50)	6 (46)
Exsmoker	19 (23)	6 (30)	3 (21)	5 (38)
Smoker	24 (29)	7 (35)	4 (29)	2 (16)
Preoperative pulmonary function				
FEV ₁ , L	2.2 ± 0.7	2.2 ± 0.6	2.4 ± 0.6	2.4 ± 0.7
FEV ₁ /FVC, %	70 ± 11	69 ± 13	69 ± 11	72 ± 8
%FEV ₁ , %	105 ± 23	114 ± 23	117 ± 27	114 ± 19
Postoperative pulmonary function				
Predictive FEV ₁ , L	2.1 ± 0.6	2.0 ± 0.5	2.0 ± 0.5	1.9 ± 0.6
Actual FEV ₁ , L	2.1 ± 0.6	2.0 ± 0.5	2.0 ± 0.5	2.0 ± 0.5
Mean tumor size, cm	1.7 ± 0.6	2.0 ± 0.7	3.1 ± 1.5	3.4 ± 1.5
Lobe underwent segmentectomy				
Right upper lobe	34 (41)	1 (5)	0	0
Right lower lobe	17 (20)	7 (35)	0	0
Left upper lobe	17 (20)	8 (40)	14 (100)	13 (100)
Left lower lobe	15 (19)	4 (20)	0	0
Number of subsegments	2.3 ± 0.8	4.6 ± 0.8	6 ± 0	10 ± 0
Total number of cases	83	20	14	13

Values are presented as n (%) or mean ± standard deviation. LUD, Left upper division; LUL, left upper lobe; FEV₁, forced expiratory volume in 1 second; FVC, forced vital capacity.

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