Exercise capacity after lobectomy in patients with chronic obstructive pulmonary disease

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Abstract

The aim of this study is to clarify whether patients with chronic obstructive pulmonary disease (COPD) lose less exercise capacity after lobectomy than those without COPD, to the same extent as ventilatory capacity and lobectomy for selected patients with severe emphysema improve exercise capacity like ventilatory capacity. Seventy non-COPD patients (N group), 16 mild COPD patients (M group), and 14 moderate-to-severe COPD patients (S group) participated. Pulmonary function and exercise capacity tests were performed on the same day preoperatively and six months to one year after lobectomy. The S group lost significantly less FEV1 (forced expiratory volume in 1 s) after lobectomy than did the N or M group (P<0.0001 and P<0.005). However, their loss of exercise capacity was equivalent to that for the N and M groups. For the S group, there was a significant, negative correlation between preoperative FEV1 % of predicted and percentage change in FEV1 and maximum oxygen consumption (V\textsubscript{O2 max}) after lobectomy (r =−0.93, P<0.0001 and r =−0.64, P=0.01). In moderate-to-severe COPD patients, patients with a lower preoperative FEV1 % of predicted experienced a smaller decrease in FEV1, and V\textsubscript{O2 max} after lobectomy. © 2008 Published by European Association for Cardio-Thoracic Surgery. All rights reserved.

Keywords: Lung cancer; Exercise capacity; Lobectomy; Chronic obstructive pulmonary disease

1. Introduction

Despite recent advances in chemotherapy and radiotherapy, surgery remains the best treatment for patients with early-stage non-small cell lung cancer. Many patients with lung cancer are old [1] and have chronic obstructive pulmonary disease (COPD) [2]. Pulmonary resection decreases ventilatory capacity [3] and reduces exercise capacity [4–6], thereby lowering their quality of life [1].

Recent studies show that patients with COPD lose less ventilatory capacity after lobectomy than do those without COPD [7–9]. Moreover, for selected patients with severe emphysema, ventilatory capacity has even been found to improve after lobectomy for lung cancer [7, 9]. However, change in exercise capacity, an important measure of quality of life, after lobectomy in patients with COPD remains unclear. The aim of this study is to clarify whether patients with COPD lose less exercise capacity after lobectomy than do those without COPD to the same extent as ventilatory capacity and lobectomy for selected patients with severe emphysema improve exercise capacity like ventilatory capacity. In this study, we compared ventilatory capacity and exercise capacity after lobectomy for lung cancer between COPD and non-COPD (without COPD).

2. Materials and methods

We retrospectively reviewed data for 428 patients who underwent lobectomy for non-small cell lung cancer at Nara Medical University Hospital between January 1997 and December 2005. Exclusion criteria were right middle lobectomy (n=30), failure to quit smoking postoperatively (n=10), receipt of adjuvant chemotherapy or radiotherapy (n=70), and postoperative empyema or moderate-to-severe pulmonary complications (n=21). We also excluded patients with preoperative segmental or lobar atelectasis (n=71) or a tumor more than 4 cm in diameter (n=51), because lack of function of the resected lung tissue was not necessarily due to emphysema. We also excluded five patients who had strongly impaired pulmonary function after lobectomy, with weaker function than expected, due to severe narrowing of the orifice of the right intermediate bronchus or left lower bronchus.

Of the remaining 170 patients, 30 could not perform preoperative exercise tests for the following reasons: five had severely limiting musculoskeletal disorders and 25 did not consent exercise tests. One hundred and forty patients underwent preoperative evaluation consisting of pulmonary function tests and exercise tests. Forty patients could not be re-evaluated for the following reasons: two died within 30 days after surgery, four had progressive metastatic disease, and 34 could not be contacted after surgery. Thus, 100 patients were enrolled in the study.

Pulmonary function and exercise tests were performed on the same day before surgery and again six months to one year after surgery. The mean interval between lobectomy and postoperative evaluation was 7.9±1.8 months. Exercise capacity was determined using an incremental exercise
However, there were similar reductions in exercise capacity (the N or M group) as well. The moderate-to-severe COPD group comprised patients with preoperative FEV1 % of predicted and percentage change in FEV1 < 80% vs. N group. There was no significant relationship between percentage change in FEV1 and percentage change in VO2 max or workload. In the S group, there was no significant correlation between percentage change in FEV1 and percentage change in VO2 max or workload. In the S group, there was a significant negative correlation between percentage change in FEV1 and percentage change in VO2 max and percentage change in workload (Table 4).

4. Discussion

Staging and classification of COPD are based on FEV1. FEV1 is a simple, reliable measurement that is of unquestionable diagnostic utility and enables accurate assessment of dis-
Table 3
Correlation between preoperative FEV\textsubscript{1} % of predicted and percentage change in FEV\textsubscript{1} or exercise capacity after lobectomy in COPD patients

<table>
<thead>
<tr>
<th>Preoperative FEV\textsubscript{1} % of predicted</th>
<th>M group</th>
<th>S group</th>
<th>COPD group (M+S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% change in FEV\textsubscript{1}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( r )</td>
<td>0.19</td>
<td>-0.93</td>
<td>-0.60</td>
</tr>
<tr>
<td>( P )</td>
<td>0.48</td>
<td>&lt;0.0001*</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>% change in ( V\textsubscript{O2 max} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( r )</td>
<td>-0.22</td>
<td>-0.64</td>
<td>-0.33</td>
</tr>
<tr>
<td>( P )</td>
<td>0.42</td>
<td>0.01*</td>
<td>0.07</td>
</tr>
<tr>
<td>% change in workload</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( r )</td>
<td>-0.29</td>
<td>-0.25</td>
<td>-0.192</td>
</tr>
<tr>
<td>( P )</td>
<td>0.27</td>
<td>0.39</td>
<td>0.31</td>
</tr>
</tbody>
</table>

\*Significant negative relationship between preoperative FEV\textsubscript{1} % of predicted and percentage change in FEV\textsubscript{1} after lobectomy. \*Significant negative relationship between preoperative FEV\textsubscript{1} % of predicted and percentage change in \( V\textsubscript{O2 max} \) after lobectomy.

COPD, chronic obstructive pulmonary disease; FEV\textsubscript{1}, forced expiratory volume in 1 s; \( V\textsubscript{O2 max} \), maximum oxygen consumption.

Table 4
Correlation between percentage change in FEV\textsubscript{1} and percentage change in exercise capacity after lobectomy

<table>
<thead>
<tr>
<th>% change in FEV\textsubscript{1}</th>
<th>N group</th>
<th>M group</th>
<th>S group</th>
<th>COPD group (M+S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% change in ( V\textsubscript{O2 max} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( r )</td>
<td>0.01</td>
<td>0.39</td>
<td>0.61</td>
<td>0.54</td>
</tr>
<tr>
<td>( P )</td>
<td>0.93</td>
<td>0.14</td>
<td>0.02*</td>
<td>0.002*</td>
</tr>
<tr>
<td>% change in workload</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( r )</td>
<td>0.02</td>
<td>0.47</td>
<td>0.19</td>
<td>0.24</td>
</tr>
<tr>
<td>( P )</td>
<td>0.87</td>
<td>0.07</td>
<td>0.52</td>
<td>0.2</td>
</tr>
</tbody>
</table>

\*Significant relationship between percentage change in FEV\textsubscript{1} and percentage change in \( V\textsubscript{O2 max} \) after lobectomy.

COPD, chronic obstructive pulmonary disease; FEV\textsubscript{1}, forced expiratory volume in 1 s; \( V\textsubscript{O2 max} \), maximum oxygen consumption.

ease progression. However, FEV\textsubscript{1} only weakly correlates with exercise capacity and dyspnea [10, 11]. Moreover, while FEV\textsubscript{1} is a surrogate measure for respiratory impairment, only \( V\textsubscript{O2 max} \), or exercise capacity, is a function of blood flow and oxygen extraction and can be influenced by a number of factors involving the cardiovascular, respiratory, and/or musculoskeletal systems [12]. In patients with COPD, exercise capacity is difficult to predict based on lung function and correlates better with dyspnea and quality of life than does FEV\textsubscript{1} [13].

Recent experience with lung volume reduction surgery suggests that predicted postoperative FEV\textsubscript{1} might be underestimated in patients with COPD undergoing lobectomy for lung cancer [7–9]. In addition, COPD patients with a lower FEV\textsubscript{1} might experience a smaller loss of pulmonary function after lobectomy [7–9]. However, post-lobectomy change in exercise capacity, an important measure of quality of life, in patients with COPD remains unclear. In this study, moderate-to-severe COPD patients lost less FEV\textsubscript{1} than did non-COPD or mild COPD patients. In addition, moderate-to-severe COPD patients with a lower preoperative FEV\textsubscript{1} % of predicted experienced a smaller reduction in FEV\textsubscript{1} and \( V\textsubscript{O2 max} \) after lobectomy. As COPD patients with a lower preoperative FEV\textsubscript{1} % of predicted have more emphysema-
tous lungs, lobectomy would produce a greater volume reduction and they would lose less FEV1 [7]. However, it is less apparent why moderate-to-severe COPD patients with a lower preoperative FEV1, % of predicted experienced a smaller reduction in VO2 max after lobectomy. VO2 max can be influenced by a number of factors involving the cardiovascular, respiratory, and/or musculoskeletal system [12]. Lobectomy loses ventilatory capacity and pulmonary blood flow. So, we suggested that change in VO2 max after lobectomy would be most affected by change in ventilatory capacity and pulmonary blood flow. As moderate-to-severe COPD patients have poor pulmonary blood flow in their emphysematous lungs, they would experience little change in pulmonary blood flow after lobectomy. Thus, for these patients, the change in VO2 max is mostly affected by change in ventilatory capacity, such that those with a lower preoperative FEV1, % of predicted would experience a smaller reduction of VO2 max after lobectomy and a smaller decrease in FEV1.

Several investigators have examined the changes in ventilatory capacity and exercise capacity at various time points between three and six months after lobectomy [4–6]. Reported reductions vary from 8% to 17% for FEV1, from 7.3% to 14% for FVC, from 0% to 13% for VO2 max and from 0% to 12% for workload [4–6]. In the present study, in moderate-to-severe COPD patients, there was a 4.7% increase in FEV1, an 8.6% reduction in FVC, a 9.7% reduction in VO2 max, and a 6.0% reduction in workload between six months and one year after lobectomy. These patients’ reduction of exercise capacity (VO2 max and workload) was equivalent to that of non-COPD and mild COPD patients. Similarly, Bobbio et al. recently showed that three months after lobectomy the FEV1 of COPD patients was not significantly altered, whereas the VO2 max was significantly reduced [14]. Larsen et al. reported that change in FEV1 is a poor predictor of change in exercise capacity [6]. In addition, Pelletier et al. reported a significant relationship between percentage change in FEV1 and percentage change in workload after major lung resections; the correlation was higher in patients with a lower preoperative FEV1, of predicted [4]. We found a significant relationship between percentage change in FEV1 and percentage change in VO2 max in moderate-to-severe COPD patients. We offer a similar explanation to that above: as in moderate-to-severe COPD patients the change in VO2 max is mostly affected by change in ventilatory capacity, change in VO2 max correlates better with change in FEV1.

Selected severe COPD patients who undergo lobectomy experience an increase in FEV1, and a decrease in FVC [7, 9]. Moreover, we and Bobbio et al. demonstrated that such patients experience a reduction in VO2 max [14]. In contrast, severe COPD patients who undergo lung volume reduction surgery achieve increased ventilatory capacity and VO2 max [15]. We suggest that the reduction of FVC and VO2 max after lobectomy in severe COPD patients is due to resection of some functioning lung tissue; if only non-functioning lung is removed, FVC and VO2 max should increase, as is the case in patients undergoing lung volume reduction surgery.

This study has certain limitations. Our study consisted of a small, retrospective analysis. Moreover, there are large discrepancies between the number of patients included in non-COPD group and that of patients included in the COPD groups. However, we believe that our findings make a contribution as a valuable addition to the field of thoracic surgery. Moreover, we also believe a large, prospective analysis could confirm these findings and clarify the more definitive conclusion about the change in exercise capacity after lobectomy in COPD patients.

In conclusion, this suggests that among moderate-to-severe COPD patients, those with a lower preoperative FEV1, % of predicted experienced a smaller reduction in FEV1 and VO2 max after lobectomy, and the change in VO2 max correlated better with the change in FEV1.

References


