The Effects of a Self-Training Physiotherapy Program on Pulmonary Functions, Postoperative Pulmonary Complications and Post-thoracotomy Pain after Lobectomy of Patients with Lung Cancer

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Abstract. [Purpose] The aim of this study was to examine the effects of a self-training physiotherapy program (STPP) on the pulmonary functions, postoperative pulmonary complications (PPCs), and post-thoracotomy pain of patients who had undergone lobectomy due to lung cancer. [Subjects] STPP was performed for 4 weeks by 15 patients who had undergone lobectomy for lung cancer. [Methods] Forced expiratory volume for one second (FEV1) and forced vital capacity (FVC) was measured before surgery, 2 weeks after surgery, and 4 weeks after surgery. The occurrence of PPCs during the two-week hospitalization period was recorded. Post thoracotomy pain was measured 1 day after surgery, 2 weeks after surgery, and 4 weeks after surgery. [Results] FEV1 and FVC were significantly decreased at 2 weeks after surgery, as compared to before surgery, but had significantly increased at 4 weeks after surgery, as compared to 2 weeks after surgery. PPCs did not occur in any subject. Post-thoracotomy pain had significantly decreased at 4 weeks after surgery, as compared to 1 day after surgery. [Conclusion] STPP has positive effects on pulmonary functions after lobectomy for lung cancer, and prevented of PPCs. However, the alleviation of post-thoracotomy pain may be the result of natural amelioration rather than STPP.

Key words: Self-training physiotherapy program, Lobectomy, Lung cancer

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INTRODUCTION

Patients who undergo lung resection as a surgical intervention for chronic pulmonary diseases, such as primary lung cancer, malignant lung cancer, and emphysema, develop many problems due to postoperative declines in pulmonary functions, such as alveolar ventilation, vital capacity, and functional residual capacity, and pain that occurs after surgery. Thoracotomies, such as lobectomy or pneumonectomy, cause damage to the ribs, muscles, peripheral nerves, etc., resulting in severe pain1). These post-thoracotomy pains may restrict functions such as breathing, coughing, and gas exchange, causing other postoperative pulmonary complications (PPCs)2).

Among lung resections, lobectomy or pneumonectomy related morbidity has decreased for ten years. However, the incidence rate of PPCs was shown to be high, around 49%3). Stéphan et al. reported that PPCs of patients who underwent lobectomy or pneumonectomy gradually decreased, but PPCs related to the respiratory system show the highest rate among PPCs4).

Recently, great attention has been paid to respiratory physiotherapy as a method of minimizing these PPCs5). However, previous studies have not included a self-training program or respiratory exercise for maintaining and improving pulmonary function after discharge. Additionally, previous studies have only focused on PPCs.

This study was conducted to examine the effects of a self-training physiotherapy program (STPP) for patients who underwent lobectomy. STPP was introduced for cost reduction and effective self-management during the 2 week hospitalization period, and in order to examine the effects of self-training on the patients’ pulmonary functions, PPCs, and post thoracotomy pain 2 weeks after discharge.

SUBJECTS AND METHODS

The study subjects were 20 patients who had undergone lobectomy due to lung cancer and were hospitalized in Pusan National University Hospital from October 2010 to March 2011. All the subjects received explanations regarding the purpose and procedure of the study and voluntarily agreed to take part. Those who had congenital thoracic deformation, rib fractures, other respiratory diseases, or complications were excluded from the study. Additionally, we excluded those patients who did not perform the STPP perfectly.
during hospitalization, or after discharge. The subjects who completed this study were 15 in total, consisting of 8 males and 7 females.

The STPP was performed by patients from the day following lobectomy surgery. The STPP consisted of 30 minutes of patient education and 30 minutes of learning breathing self-training under a physiotherapist’s supervision, including diaphragmatic respiration, inspiratory muscle training, pulmonary segment breathing methods, and coughing practice until postoperative day 3. After 3 days, patients conducted breathing self-training without a supervisor for 1 hour a day. From the second week, additionally, patients learned the exercises for joint mobilization, shoulder and thoracic cage flexibility, corridor walking, and ascending and descending stairs. The patients were recommended to perform the STPP for 1 hour a day, 5 days a week during the 2 weeks of hospitalization.

After being discharged from hospital, the patients were encouraged to carry out the STPP at home. All the patients performed the STPP from the day following discharge. They were asked to record their self-training time each week on a special sheet. They were recommended to perform the STPP for 1 hour a day, 5 days a week for the initial 2 weeks at home. All tests and STPP teaching in this study were implemented by one skilled professional respiratory physiotherapist.

A Micro LAB Spirometer (Carefusion GERMANY, Ireland) was used as the pulmonary function test (PFT) tool to test forced expiratory volume for one second (FEV1) and forced vital capacity (FVC). The measurements were conducted before surgery, 2 weeks after surgery, and 4 weeks after surgery. The PFT at 2 weeks after surgery was performed by the patients who would be discharged within postoperative 12–16 days. Since most of the patients were discharged 2 weeks after surgery, the PFT at 4 weeks after surgery was conducted when the patients revisited the hospital from 2 to 3 weeks after discharge.

The VAS (Visual Analogue Scale) was used to assess post-thoracotomy pain in relation to the performance of STPP after lobectomy. VAS is a clinical pain assessment tool that quantifies subjective pain on a linear scale from 0 (no pain) to 10 (severest pain)6). Post-thoracotomy pain was assessed 1 day after surgery and also at 2 weeks and 4 weeks after surgery.

Friedman tests were conducted to examine the effects of STPP after lobectomy for lung cancer on pulmonary functions and post-thoracotomy pain, and Wilcoxon signed rank tests were conducted to compare the differences between measurement time points. The incidence rate of PPCs was processed as a percentage. Statistical processing was conducted using SPSS 17.0 for Windows, with the significance level, α, chosen as 0.05.

RESULTS

The subjects’ mean age was 58.60 ± 12.43, their mean height was 161.93 ± 7.57 cm, their mean weight was 60.89 ± 11.69 kg, and their mean BMI was 23.22 ± 4.14. Both FEV1 and FVC had decreased at 2 weeks after surgery as compared to before surgery, but had increased at 4 weeks after surgery, with significant difference (Table 1). PPCs did not occur in any subject after surgery until immediately before discharge. Post-thoracotomy pain showed significant decreases from 1 day after surgery to 4 weeks after surgery (Table 2).

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<tr>
<th>Table 1. Pulmonary functions in relation to STPP after lobectomy</th>
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<td>Preoperative</td>
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<tr>
<td>FEV1</td>
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<td>FVC</td>
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(N=15) FEV1: forced expiratory volume at one second; FVC: forced vital capacity; a, b, c values with different superscripts within the same column are significantly different, p<0.05

<table>
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<th>Table 2. Post-thoracotomy pain in relation to STPP after lobectomy</th>
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<tr>
<td>1 Day</td>
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<tr>
<td>VAS]</td>
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<td>4.73±2.19a]</td>
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(N=15) a, b, c values with different superscripts are significantly different, p<0.05

DISCUSSION

In this study, when STPP was performed, FEV1 and FVC at 2 weeks after surgery significantly decreased, becoming 83.8% and 71.68% of their preoperative values, respectively. However, in this study, FEV1 and FVC at 2 weeks after surgery were higher compared to the FEV1 (64.49%) and FVC (62.76%) at 4 weeks after surgery in a previous study7) in which physiotherapy intervention was not administered. In addition, in this study, FEV1 (83.8%) and FVC (71.68%) at 2 weeks after surgery were higher than or close to the FEV1 (77.9%) and FVC (74.5%) at 4 weeks after surgery, thereby showing considerable differences with the FEV1 (92.59%) and FVC (81.36%) at 2 weeks after surgery reported in a previous study8) in which only lobectomy was performed. In a study conducted by Nosotti et al.9) in which only a surgical intervention was made, all groups that had undergone the intervention showed recovery of both FEV1 and FVC to around 72% of preoperative levels at 4 weeks after surgery, thereby showing considerable differences with the FEV1 (92.59%) and FVC (81.36%) at 4 weeks after surgery that were found in the present study. Based on this, we believe that the performance of STPP minimized the rapid decline in pulmonary function that may occur 1–2 weeks after lobectomy due to lung cancer because of thoracotomy effects that contribute to the recovery of pulmonary functions.

Our review of previous studies8, 10, 11) in which pulmonary functions were followed up on after lobectomy for lung cancer without physiotherapy intervention, it revealed that pulmonary functions recover by at least 85% or reached their peaks by 6 months after lobectomy. In this study, the pulmonary functions at 4 weeks after surgery were close to the levels of pulmonary functions reported at 6 months.
after surgery in previous studies. In particular, in this study, FEV1 at 4 weeks after surgery was shown to be higher than the values measured at 6 months after surgery in previous studies\textsuperscript{10, 11}.

FEV1 increases are closely related with post-thoracotomy pain\textsuperscript{12}. Varela et al.\textsuperscript{13} stated that when VAS scores for pain were lower, higher FEV1 was shown. In this study as well, as post-thoracotomy pain decreased continuously and significantly, FEV1 increased gradually. We think this is because the pain generated by the pressure imposed on tissues around the surgery site during maximum expiration for FEV1 measurement was alleviated.

In a study by Nosotti et al.\textsuperscript{9} in which respiratory rehabilitation was not administered, all patients who had undergone lobectomy showed pain scores of around 3.2–3.5 immediately after surgery regardless of the surgical intervention method, and the scores decreased to around 1.5 by 4 weeks (around 1 month) after surgery. In this study, the pain score immediately (1 day) after surgery was around 4.73 and had decreased to around 2 at 4 weeks after surgery. Although direct comparison is difficult because no control group existed in this study, in a previous study\textsuperscript{9}, pain alleviation of only around 0.73 was reported. Based on this result of indirect comparison, it is difficult to determine whether the alleviation of post-thoracotomy pain resulted from the performance of STPP or the natural alleviation of pain over time.

Stephan et al.\textsuperscript{3} reported that after lobectomy, 58 patients (40.85\%) out of 142 experienced PPCs, and breathing related PPCs showed the largest number of cases at 41 (28.87\%). Nakanishi et al.\textsuperscript{14} who performed only surgical interventions for lung cancer patients, reported that PPCs occurred in 21 patients (21.2\%) out of 99. PPCs did not occur in any subject (15 patients) of this study. Although this cannot be generalized, because the number of subjects in this study was small, it indicates that STPP can positively affect the prevention of PPCs. In addition, since Reid et al.\textsuperscript{15} stated that the size of the effect of preoperative physiotherapy education was zero, respiratory self-training applied after surgery, such as STPP, are considered to be more important for the prevention of PPCs. Additionally, introduction of the STPP would reduce medical cost and patient management.