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Effects of a Balloon-Blowing Exercise on Lung Function of Young Adult Smokers

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Abstract. [Purpose] The aim of this study was to clarify the lung capacity when a balloon-blowing exercise was used to increase patients' lung function. [Subjects] The subjects of the study were 30 young smokers. [Methods] Subjects were randomly divided two groups; The experimental group (n=15) performed a balloon-blowing exercise. The control group (n=15) performed no exercise. [Result] The results indicate that VC, ERV, IRV, FVC, FEV1, FEV1/FVC, PEF significantly improved in the experimental group. In contrast, VC, ERV, IRV, FVC, FEV1, FEV1/FVC, PEF did not significantly change in the control group. There were significant differences in VC, ERV, IRV, FVC, and FEV1 between the experimental group and the control group after the performance of the balloon-blowing exercise. [Conclusion] These findings suggest that the balloon-blowing exercise has positive effects on lung function.
Key words: Smokers, Balloon-blowing exercise, Lung function

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INTRODUCTION

Smoking cigarettes progressively impairs pulmonary functions. Quitting smoking is the only way to prevent impairment of pulmonary functions, but most smokers fail to stop smoking. As a result, chronic obstructive lung disorders are found in about 15–20% of smokers, chronic bronchitis symptoms in 50%, and only 30% are healthy smokers[1)].

The physiological effects of smoking on human respiratory organs include asthma and bronchitis, which are induced by the noxious substances of cigarette smoke irritating the respiratory tract, lowered pulmonary functions due to increased respiratory tract resistance and obstruction, and other negative effects such as change in lung elasticity, increased obstructed volume, an abnormal respiration curve and reduced diffusivity[2–5)].

In a study of the reductions of pulmonary functions induced by smoking[4)], a smoking group showed lower vital capacity, forced expiratory volume rate in one second and maximum ventilation than the non-smoking group. Hence, coordinative motion of respiratory muscles is required to increase the respiratory volume of smokers. Rib expansion to the top and sides along with descent of the diaphragm increases the intrapleural volume, creating negative pressure, which results in air inflow to the lungs during inspiration. During expiration, the air is discharged to the outside passively by the relaxation of the muscles. Thus, I the accessory inspiratory and expiratory muscles need to be used for respiration. It was reported that expiratory muscle training can increase the respiratory muscular strength, resulting in reduced respiratory distress, and improve motor ability by changing the type of respiration[6)].

The conventional training methods for respiratory muscle strengthening that have been used to treat subjects having lowered pulmonary functions due to central nervous system disorders are diaphragmatic respiration, ventilator muscle training, glossopharyngeal respiration and pursed lip breathing[7)]. Training based on a feedback respiration training instrument[8)] and intermittent positive pressure breathing were also reported to be able to improve pulmonary functions[9)].

Recently, Lee et al.[10)] reported that respiratory muscle strengthening with an instrument by cigarette smokers in their 20's, for inspiratory and expiratory resistance, improved the respiration ability. Lee et al.[11)] conducted a balloon-blowing study with healthy non-smokers and reported that balloon-blowing increased the maximum expiratory volume. They commented that, in balloon-blowing, greater action of the respiratory muscles is required as the volume of the balloon increases, because the resistance is increased by the air blown in into the balloon.

Most respiration-related studies have been conducted with expensive instruments under the guidance of therapists with the subjects being patients with central nervous system disorders. Although balloon-blowing can strengthen the expiratory muscles, it has been studied insufficiently. In particular, few studies have been conducted on the effect of balloon-blowing by healthy smokers whose pulmonary functions are decreased year by year due to smoking. Therefore, in this study we investigated whether balloon-

Table 1. The general characteristics of the subjects

Group	Age (years)	Height (cm)	Weight (Kg)	Number (each)	Duration (Month)	Regular exercise
Balloon exercise	22.27 ± 1.79	177.20 ± 4.83	69.07 ± 6.83	11.80 ± 4.71	55.87 ± 34.92	no
Control group	22.87 ± 2.45	174.80 ± 5.02	64.00 ± 8.07	10.40 ± 4.21	63.20 ± 28.50	no

Mean ± SD, Number: Number of cigarettes smoked per day, Duration: Duration of smoking, *$p<0.05$

blowing training can improve the pulmonary functions of healthy smokers using balloons that are readily available.

SUBJECTS AND METHODS

The subjects of this study were 30 healthy smokers having no disorders in respiration. The chosen subjects were 30 students who agreed to participate in the training program. Each of the subjects was asked to take ticket, numbered "1" or "2" and were randomly allocated one of two groups according to the ticket number: those with the No. 1 ticket to the balloon-blowing training group and those with the No. 2 ticket to the control group. Table 1 shows the homogeneity of the smokers tested with respect to the mean smoking period, number of cigarettes per day and other general characteristics. Since regular exercise can affect the pulmonary functions, the subjects were chosen from among those who performed exercise for less than two hours per week, or those who performed exercise irregularly.

Fifteen subjects in the balloon-blowing training group carried out the predetermined balloon-blowing exercise for eight weeks, three times each week. The balloon-blowing assignment was for the subjects to breathe in the upright position before the exercise using a respiration method that each of them could perform. They were asked to breathe in air through the nose to the maximum, breathe out into the balloon at the maximum rate, and maintain the state for one second. After that, they were asked to immediately close the balloon mouth with the fingers, breathe in to the maximum once again, and then breathe out into the balloon. The subjects adopted the upright position in this study because Allen et al.[12] reported that the respiratory capacity was greater by 7.5% in the upright position than in the sitting position. The balloon-blowing exercise was performed two times at maximum balloon-blowing over one minute. The exercise was repeated three times to complete one set. On one exercise occasion, a total of three sets were performed. One minute of rest was given between sets to reduce muscular fatigue. The training was stopped whenever the subjects felt dizziness or experienced heart pain. To avoid valsalva during balloon-blowing, the subjects were asked not to hold their breath for more than five seconds following the maximum expiration. To ensure homogeneity in the number of cigarettes smoked between the balloon-blowing group and the control group, the mean number of cigarettes smoked per day was set to be 11 in a preliminary survey.

The pulmonary functions were measured in the sitting position using CardioTouch 3000S (BIONET). Obstructive or restrictive pulmonary diseases were checked by measuring vital capacity (VC), inspiratory reserve volume (IRV), expiratory reserve volume (ERV), forced vital capacity (FVC) forced expiratory volume in one second (FEV1) and the ratio of FEV1 to FVC (FEV1/FVC, %). The airway resistance was measured by measuring peak expiratory flow (PEF).

Before the measurement, the method was explained to the subjects who were seated in a comfortable position. After being shown an example, the subjects were measured with their noses blocked and having a mouthpiece in the mouth. The pulmonary functions were measured by asking the subjects to breathe three times as usual, breathe in to the maximum, breathe out as strongly and quickly as possible, and then breathe in again.

The collected data were analyzed using SPSS ver. 12.0. All the parameters for all the subjects were tested by the Kolmogorov-Smirnov test, which showed showing that the data were normally distributed. The independent t-test was performed to test the homogeneity of the experimental and control group. The paired t-test was performed to verify the change in the pulmonary indices before and after the experiment, and the independent t-test was performed to test the differences between the groups before and after the experiment. The significance level, p, was chosen as 0.05.

RESULTS

The VC, ERV, IRV, FVC, FEV1, FEV1/FVC and PEF of the balloon-blowing group had significantly improved after the experiment when compared with their respective values before the experiment ($p<0.05$). However, the values of the control group were not significantly different between before and after the experiment ($p>0.05$). Comparison of the pulmonary functions between the balloon-blowing group and the control group after the exercise showed a significant difference in VC, ERV, IRV, FVC and FEV1 ($p<0.05$) (Table 2). However, there was no significant differences in FEV1/FVC and PEF ($p>0.05$) (Table 2).

DISCUSSION

Cigarette smoking is very closely associated with the onset of chronic respiratory disorders and it progressively reduces pulmonary functions. Therefore, in this study, we investigated whether respiration training by means of balloon-blowing can effect a significant difference in the pulmonary function indices.

The results of the study show that the pulmonary functions of the balloon-blowing training group were significantly improved compared to those of the non-training group, indicating that balloon-blowing training had a positive effect on the improvement of pulmonary functions of young male smoker.

Table 2. The effect of balloon-blowing exercise on smokers

Variable		Balloon exercise	Control Group
VC(L)*	pre	5.70 ± 0.98	5.82 ± 2.14
	post	7.46 ± 2.33*	5.78 ± 1.97
ERV(L)*	pre	1.67 ± 0.57	1.96 ± 0.48
	post	2.43 ± 0.68*	1.84 ± 0.77
IRV(L)*	pre	3.33 ± 0.60	3.35 ± 2.14
	post	4.28 ± 0.86*	3.38 ± 2.15
FVC(L)*	pre	3.25 ± 0.65	3.36 ± 0.39
	post	4.27 ± 0.53*	3.25 ± 0.47
FEV1(L)*	pre	3.25 ± 0.41	3.35 ± 0.56
	post	3.86 ± 0.42*	3.39 ± 0.54
FEV1/FVC (%)	pre	89.55 ± 7.76	92.56 ± 9.18
	post	94.66 ± 7.51*	92.33 ± 8.84
PEF(L/S)	pre	6.54 ± 1.93	6.42 ± 1.49
	post	7.16 ± 1.55*	6.44 ± 1.48

Mean ± SD; VC: vital capacity; ERV: expiratory reserve volume; IRV: inspiratory reserve volume; FVC: forced vital capacity; FEV1: forced expiratory volume at one second; FEV_1/FVC(%): forced expiratory volume at one second / forced vital capacity; PEF: peak expiratory flow; *$p<0.05$

We investigated the effect of balloon-blowing over eight weeks, since Pyeon et al.[13] reported that respiration training longer than four weeks was effective at improving pulmonary functions in patient with spinal damage. The pulmonary function indices were evaluated with a spirometer that has been used for the respiratory evaluation of patients with cervical spinal cord injury[9].

Our result show that VC, ERV, IRV, FVC, FEV1, FEV1/FVC and PEF significantly increased in the balloon-blowing exercise group, while there were no significant changes in the control group. Comparison between the two groups showed that the VC, ERV, IRV, FVC and FEV1 after the eight weeks of the intervention improved more in the balloon-blowing exercise group than in the control group.

Pyeon et al.[13] stated that expiration is a passive process which occurs through natural relaxation of the diaphragm and intercostal muscles, and that when forced expiration is performed, the abdominal muscles, such as the rectus abdominus and transverse abdominal actively contract. The balloon-blowing exercise performed in our study inflated a balloon with air blown in, and the elastic force of the rubber increased, resulting in more resistance to the abdominal muscles. It was reported that the expiratory muscles and abdominal muscles becomes more active as the volume of the balloon is increased[11]. Therefore, the expiratory muscles and abdominal muscles might have been strengthened by the balloon-blowing exercise used in our study.

Previous studies of expiratory training include the study by Rothman[14] in which expiratory exercise and thorax expansion exercise were performed for two weeks by five subjects in an experimental group recruited from 10 rigid cerebral palsy children. Diaphragmatic respiration and abdominal muscle strengthening, resulted in increased VC and FEV. Smeltzer et al.[15] conducted expiratory muscle strengthening exercise for three months for 15 multiple sclerosis patients and reported an increase in the expiratory muscle strength. Lee et al.[8] performed respiratory training for four weeks using thorax resistance and diaphragmatic respiration exercises with a bio-feedback training instrument that modulated inspiration and expiration training, and reported that FVC, FEV1 and PEF were significantly increased. These results are similar to the results of our study in which expiratory muscle strengthening training was performed for eight weeks using balloon-blowing.

Lee et al.[10] conducted balloon-blowing for five weeks for 20 adults who were not limited in respiratory function and reported that the PEF value was significantly increased. Lee et al.[11] also conducted inspiratory and expiratory muscles strengthening training for 20 healthy subjects using the Ultrabreath respiratory training instrument and reported that the training increased PEF. This result is consistent with the result of our study that PEF was significantly increased by the expiratory muscle strengthening training using balloons.

In the study of Jeon et al.[9], effects of the expiratory and inspiratory exercise methods for the improvement of pulmonary function in patients with cervical spinal cord injury were compared, and the result showed that the respiratory indices were significantly improved after the training in the expiratory training group, although there were no significant difference in the pulmonary functions in the inspiratory training group. This indicates that the positive result found in our balloon-blowing exercise group was probably related to the balloon-blowing exercise in this study was focused on the expiratory exercise rather than inspiratory exercise.

This study investigated the effects of balloon-blowing training on the pulmonary functions of 30 smokers in their of 20's, by dividing them into the a balloon-blowing group and a control group. The results show that the pulmonary function indices significantly increased after eight weeks of exercise in the balloon-blowing group. However, the control group did not show any significant differences after the eight weeks. A comparison of the two groups showed that the pulmonary function indices were increased significantly more in the balloon-blowing group but not in the control group. Therefore, we conclude that balloon-blowing exercise improves the pulmonary functions of healthy smokers.

This study had several limitations. First, the subjects were limited to 30 male smokers, and the number of subjects was insufficient for at subjects in each group. Second, the relative resistance of the balloons was not constant during balloon-blowing because of individual differences. Therefore, future studies need to be conducted with more subjects, measuring the balloon resistance accurately.

REFERENCES

1) Willemse BW., Postma DS, Timens W, et al.: The impact of smoking cessation on respiratory symptoms, lung function, airway hyperresponsiveness and inflammation. Eur Respir J, 2004, 23: 464–476. [Medline] [CrossRef]
2) Kim HD, Lee KK: The influence of Long term smoking and exercise habits on cardiopulmonary function and risk factor of cardiovascular disease in adult male. Exerc Sci, 2009, 18: 165–172.
3) Jeong HM, Wee SD, Yoon PJ, et al.: The effect of tendency smoking on pulmonary function in different age group. Exerc Sci, 2002, 11: 85–91.
4) Cha KS: A comparison of pulmonary function, aerobic power, blood pressure, blood hemoglobin in smokers and non − smokers. Kor J Phys Educ, 2001, 40: 845–857.
5) Knapik J, Zoltick J, Rottner HC, et al.: Relationships between self-reported physical activity and physical fitness in active men. Am J Prev Med, 1993, 9: 203–208. [Medline]
6) Lee SM, Kang JH, Ko TS, et al.: Cardiovascular and pulmonary physical therapy. In: Pulmonary Rehabilitation and Intervention, 1st Edition, Seoul: Hyun Moon, 2011, pp 216–246.
7) Kisner C, Colby LA: Therapeutic exercise: foundations and techniques. In: Management of Pulmonary Conditions, 4th Edition, Philadelphia: FA Davis, 2002, pp 738–772.
8) Lee JH: The Effect of Pulmonary Function in the Stroke Patients after feedback breathing exercise. Kyoung San: Daegu University Press, 2008 (dissertation).
9) Jeon YJ, Oh DW, Kim KM, et al.: Comparison of the effect of inhalation and exhalation breathing exercises on pulmonary function of patients with cervical cord injury. Phys Ther Kor, 2010, 17: 9–16.
10) Lee SC, Jung CH, Lee ES, et al.: Changes of respiratory ability according to respiratory muscle exercisees for smokers and non smokers in their twenties. J Kor Phys Ther Sci, 2011, 18: 9–16.
11) Lee SC, Sin SH, Jung JY, et al.: The effects of balloon blow-ups and upper abdominal exercise on respiratory rehabilitation. J Kor Phys Ther Sci, 2011, 18: 17–24.
12) Allen SM, Hunt B, Green M: Fall in vital capacity with posture. Br J Dis Chest, 1985, 79: 267–271. [Medline] [CrossRef]
13) Pyun SB, Kwon HK, Kim KH: Improved pulmonary function in the cervical cord injured after respiratory muscle training. Ann Rehabil Med, 1994, 18: 302–310.
14) Rothman JG: Effects of respiratory exercise on the vital capacity and forced expiratory volume in children with cerebral palsy. Phys Ther, 1978, 58: 421–425. [Medline]
15) Smeltzer SC, Lavietes MH, Cook SD: Expiratory training in multiple sclerosis. Arch Phys Med Rehabil, 1996, 77: 909–912. [Medline] [CrossRef]