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Original Article

The effects of a balloon-blowing exercise in a 90/90 bridge position using a ball on the pulmonary function of females in their twenties

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Abstract. [Purpose] This study was conducted to investigate pulmonary function before and after the performance of a balloon-blowing exercise in a 90/90 bridge position using a ball among female university students in their twenties. [Participants and Methods] Participants were randomly assigned to the control group, which performed the bridge position using hip and knee flexion on a ball with a diaphragm respiratory exercise, or the experimental group, which performed a 90/90 bridge using a ball with a balloon exercise. The exercise programs were conducted 30 minutes a day, five times a week for four weeks. Pulmonary function was measured with a digital equipment before and after the exercise program period. [Results] The findings suggest that the training group resulted in significant changes in forced vital capacity, vital capacity, peak expiratory flow, and forced expiratory volume at one second. There was no significant increase in maximal voluntary capacity or vital capacity, but the pre- and post-test values improved. To compare the two groups, an independent t-test was conducted to determine vital capacity, and the results showed statistically significant differences between the experimental and control groups. [Conclusion] This study showed that a balloon-blowing exercise in a 90/90 bridge position using a ball can be used to improve pulmonary function.

Key words: Pulmonary function, Bridge exercise, Balloon

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INTRODUCTION

In order to breathe, coordinated contraction of the respiratory muscles is required. The action of the downward contraction movement of the diaphragm and the expansion of the ribs in a superior outward direction increases lung volume and decreases the pressure inside the thoracic cavity, inducing inhalation by the inflow of air into the lung cavity. As the contracted muscles become relaxed, the space inside the thoracic cavity is reduced, and pressure is elevated, inducing exhalation by the outflow of air[1)]. Limited pulmonary function results in symptoms such as cough, sputum, chills, high fever, chest pain, and difficulty breathing during exercise, all of which can be caused by various modern life-related factors, such as smoking, air pollution, occupational exposure, allergies, infection, genetic predisposition, and aging. If symptoms continue to deteriorate due to persistent pulmonary disease, complications, such as the development of acute lung diseases, bacterial infection, and heart failure, often follow[2)]. Therefore, various treatments for lung disease have been developed, among which respiratory muscle-strengthening exercises have been shown to have various therapeutic effects. These effects include improved pulmonary function, exercise performance, respiratory function, and respiratory muscle strength; maintenance or improvement of chest and lumbar mobility[3)]; and correction of abnormal breathing patterns. Thus, these treatments are used to prevent complications from lung disease[4)].

Various research has been conducted to restore respiratory function among diverse patient groups. For example, functional

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breathing exercises have been used to promote vital capacity (VC) in scoliosis patients[5]; specifically, thoracic flexibility exercises have been performed on patients with scoliosis to increase the function of vital capacity (VC), expiratory residual volume (ERV), and inspiratory residual volume (IRV)[6]. Additional studies have been carried out on patients with amyotrophic lateral sclerosis to improve respiratory motion tidal volume (TV) and vital capacity (VC)[7]. For patients with muscular dystrophy, breathing volume increases normally through performance of a barrier breathing exercise[8]. All of these previous studies employed existing respiratory devices or respiratory exercises[9], and standardized breathing exercise were monitored by cardiopulmonary physiotherapists.

Based on the study methodology of Boyle et al.[10], the balloon-blowing exercise in a bridge position using hip and knee flexion is proposed here as a breathing exercise and preventive method that can be performed daily by patients without professional help. The purpose of this study is to apply the present study to the lung function enhancement based on the theory that can improve the contractile motion of the trunk respiratory muscles. Fitness effect of a bridging exercise with a balloon blowing in healthy young adults has not been previously reported. A bridging exercise with a balloon blowing has been studied previously. This study investigates the effects of this exercise program using a rubber ball on the pulmonary function of female college students in their twenties.

PARTICIPANTS AND METHODS

Fourteen female college students attending N University in Cheonan, Chungnam were selected for inclusion in this study. The selection criteria were participants without orthopedic cardiopulmonary pathology conditions, determined by a test, and participants who understood the purpose of and agreed to participate in the study. The study was approved by the clinical bioethics committee at Korea Nazarene University (KNU IRB 17-1021-09) and was reviewed according to the declaration of Helsinki. The general characteristics of the participants are shown in Table 1.

The exercise program used in this study was conducted for 30 minutes a day, five times a week for four weeks and consisted of a 90/90 bridge position using a ball with balloon blowing exercises, based on the study methodology of Boyle et al.[10] A therapeutic exercise that promotes optimal posture (diaphragm and lumbar spine position) and finely tuned neuromuscular control of the deep abdominals, diaphragm, and pelvic floor (lumbar-pelvic stabilization) would be desirable for patients with suboptimal respiration and posture. In the experimental group, participants were asked to lay on a stable floor, to place their feet on a wall, and to flex their knees and hips at a 90 degree angle. A five-inch rubber ball was inserted between the knees so that the inside and the back of the thighs felt the pressure of the ball. Then, the hips were lifted from the ground to tilt the pelvis backward. While the balloon was held with one hand, the other hand was raised above the head to create a shoulder joint angle of 120 degrees. Maintaining this posture, the participants performed a ballooning-blowing exercise, during which participants held a balloon in one hand and inhaled through the nose with the tongue on the roof of the mouth (i.e., the normal rest position) before exhaling through the mouth into the balloon. Maximum inhalation was 75% and typically 3–4 seconds in duration, and complete exhalation was 5–8 seconds in duration, followed by a 2–3 second pause. This required maintenance of intra-abdominal pressure to allow inhalation through the nose without air coming back out of the balloon and into the mouth. The participants were instructed not to grab the opening of the balloon too tightly to allow air in the balloon to enter the mouth cavity nor to use cheek muscles to blow into the balloon. The entire process was monitored by the examiner. The control group performed a diaphragmatic exercise in the same posture as the experimental group but were instructed to place a hand on their upper abdomen to verify that the abdomen ascended during inhalation and descended during exhalation.

Pulmonary function was measured in a sitting position using the Fitmate (COSMED, Sri, Italy) tool. To ensure accurate measurements, the tester explained and demonstrated the exercise to each participant beforehand. Both the experimental and control groups were instructed to use the mouthpiece of the tool and to block their nostrils during measurements so that air was neither inhaled nor exhaled through the nose. First, participants slowly exhaled to maximum level following the tester's signal, before slowly inhaling; forced vital capacity (FVC), forced expiratory volume at one second (FEV1), peak expiratory flow (PEF), vital capacity (VC), and maximal voluntary capacity (MVC) were measured at this time. Three measurements were made for each pre-test and post-test value, and the average of the three values was used as the final value. Each participant was given a five-min break after each measurement[11]. Forced vital capacity, forced expiratory volume at one second, peak expiratory flow was measured again by rapid ventilation after rapid air inspiration. Vital capacity (VC) was measured through slow ventilation after slow and deep inspirations. The maximal voluntary capacity (MVC) was measured as the participants breathed quickly and deeply for 10 seconds to determine lung capacity. According to the criteria adopted

Table 1. General participant characteristics

	Experimentals (n=10)	Controls (n=10)
Age (years)	21.1 ± 1.2	21.5 ± 1.6
Height (cm)	164.3 ± 2.3	160.3 ± 2.1
Weight (kg)	58.1 ± 6.3	56.4 ± 4.4

Values are presented as the mean ± SD.

by Scot and Jan[12], the mean value of three measurements was used for the analysis of lung capacity values.

All data were analyzed using the SPSS 16.0 statistical program. To examine differences before and after the experiment for each measured item, a t-test of matching samples was conducted, and to determine the significant of changes before and after the experiment in each group, an independent comparative t-test was performed. The significance level α was set to 0.05.

RESULTS

When comparing the breathing capacity of the experimental and control groups before and after the experiment, the experimental group showed significant changes in FVC, FEV1, and PEF ($p<0.05$). In contrast, the control group showed no significant changes in any parameters ($p>0.05$). In testing the differences between the experimental and control groups before and after the experiment, the experimental group showed a greater improvement in VC ($p<0.05$; Table 2).

DISCUSSION

This study investigated the effects of performing a 90/90 bridge position using a ball with a balloon-blowing exercise on pulmonary function in female college students in their twenties. When measurements of pulmonary function before and after the experiment were compared, it was found that the lung capacity of the experimental group was significantly increased in FVC and FEV1 compared to the control group. In addition, MVC increased, although this was not significant. The balloon resistance is most likely increased contraction of the diaphragm muscle, which is active during forced exhalation, and the respiratory cycle, with resistance, required lengthening and contracting of both the internal and external intercostal muscles, which are active during both phases of respiration. Other possible reasons for elevated expiratory flow shown in this study are further expansion of chest wall and enhanced abdominal muscle activities because of the bridged position. Lee et al.[13] reported that a balloon-blowing exercise was helpful for increasing VC, ERV, IRV, FVC, FEV1, FEV1/FVC, and PEF. Results of the current study on FVC, PEF and VC were similar to those in previous researches. Jun et al.[14] reported that the FVC, FEV1/FVC, and PEF of elderly smokers was significantly increased by performing a feedback breathing exercise and balloon-blowing exercise.

Respiratory exercises with an assist of device such as balloon are found to be effective not only in healthy young population but also in populations with neurological disorders. Jo et al.[15] reported that VC and total lung capacity were significantly increased by complex respiratory exercises in patients with cervical spinal cord injury, which is similar to the current results. Gosselink et al.[16] reported that respiratory-resistance exercises in patients with multiple sclerosis increased their FVC, which is also supported by the current study. The respiratory exercise program used in this study is highly recommended as a breathing exercise that can be performed more routinely in patients' daily lives.

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Conflict of interest

None.

Table 2. Comparison of respiratory function of each experimentals and controls

	Experimentals		Controls	
	Pre-test	Post-test	Pre-test	Post-test
FVC (l)	1.7 ± 0.2	1.8 ± 0.2*	1.6 ± 0.2	1.6 ± 0.3
FEV1 (l)	1.7 ± 0.4	1.9 ± 0.3*	1.6 ± 0.2	1.6 ± 0.4
PEF (l)	2.6 ± 0.6	3.1 ± 0.5*	2.6 ± 0.6	2.7 ± 1.3
VC (l) [a]	3.8 ± 0.2	4.0 ± 0.2	3.6 ± 0.2	3.7 ± 0.2
MVC (l)	120.7 ± 4.7	122.9 ± 4.6	117.1 ± 4.2	117.4 ± 4.3

Values are presented as the mean ± SD.
*Significant difference from pre-test at <0.05; [a] Significant difference in gains between two groups at $p<0.05$;
FVC: forced vital capacity; FEV1: Forced expiratory volume at one second; PEF: Peak expiratory flow; VC: Vital capacity; MVC: Maximal valuntary capacity.

REFERENCES

1) Yang SH: The effects of respiratory muscle strengthening exercise in smokers to the respiratory function. J Korea Entertain Ind Assoc, 2016, 10: 361–367. [CrossRef]
2) Jin SR: Respiratory. SinWon Public, 2005.
3) Troosters T, Casaburi R, Gosselink R, et al.: Pulmonary rehabilitation in chronic obstructive pulmonary disease. Am J Respir Crit Care Med, 2005, 172: 19–38. [Medline] [CrossRef]
4) Sutbeyaz ST, Koseoglu F, Inan L, et al.: Respiratory muscle training improves cardiopulmonary function and exercise tolerance in subjects with subacute stroke: a randomized controlled trial. Clin Rehabil, 2010, 24: 240–250. [Medline] [CrossRef]
5) Lee WH, Kim JS: The effects of pulmonary function and Cobb's angle in the scoliosis patients after breathing exercise in several positions. Korean J Growth Dev, 2013, 21: 25–31.
6) Sim SH, Oh DW, Lee GW: The effects of thoracic flexibility exercise on vital capacity and chest expansion in patients with idiopathic scoliosis. Korean Res Soc Phys Ther, 2002, 9: 145–156.
7) Jung YJ: Effect of breathing exercise on improvement of pulmonary function in patient with amyotrophic lateral sclerosis: case study. Korean Res Soc Phys Ther, 2001, 8: 71–80.
8) Ito M, Kakizaki F, Tsuzura Y, et al. Respiratory Muscle Conditioning Group: Immediate effect of respiratory muscle stretch gymnastics and diaphragmatic breathing on respiratory pattern. Intern Med, 1999, 38: 126–132. [Medline] [CrossRef]
9) Yong MS, Lee HY, Lee YS: Effects of diaphragm breathing exercise and feedback breathing exercise on pulmonary function in healthy adults. J Phys Ther Sci, 2017, 29: 85–87. [Medline] [CrossRef]
10) Boyle KL, Olinick J, Lewis C: The value of blowing up a balloon. N Am J Sports Phys Ther, 2010, 5: 179–188. [Medline]
11) Pryor JA: Prasad SA: Physiotherapy for Respiratory and Cardiac Problems, 3rd ed. Singapore: Churchill Livingstone, 2002.
12) Scot I, Jan ST: Cardiopulmonary physical therapy, 2nd ed. The C.V. Mosby, 1990.
13) Lee SC, Sin SH, Lee HM, et al.: The effects of balloon blow-ups and upper abdominal exercise on respiratory rehabilitation. Korean Acad Phys Ther Sci, 2011, 18: 43–53.
14) Jun HJ, Kim KJ, Nam KW, et al.: Effects of breathing exercises on lung capacity and muscle activities of elderly smokers. J Phys Ther Sci, 2016, 28: 1681–1685. [Medline] [CrossRef]
15) Jo NO, Park SW, Lee SJ, et al.: The effects of respiratory rehabilitation training on respiratory functions of cervical spinal cord injury patients. Korean J Rehabil Nurs, 2011, 10, 108–115.
16) Gosselink RA, Wagenaar RC, Rijswijk H, et al.: Diaphragmatic breathing reduces efficiency of breathing in patients with chronic obstructive pulmonary disease. Am J Respir Crit Care Med, 1995, 151: 1136–1142. [Medline]