



Original Article

An analysis of pulmonary function in different lying positions in the 20's normal adults

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Abstract. [Purpose] The purpose of this study was to study the changes in pulmonary functions in relation to lying positions of experimental participants. [Subjects and Methods] Twenty participants participated in this experiment. Measurements were taken in the supine position, the left side-lying position, the right side-lying position, and the prone position. Vital capacity (VC) was evaluated using a Fit mate. [Results] A comparison of four lying position showed significant differences in participants' VC. In comparison of four position, supine and left sidelying, and between supine and right sidelying, and between supine and prone, between left sidelying and prone. [Conclusion] In conclusion, changing the participants lying position produce changes in pulmonary functions. The greatest change occurred with a supine lying position. We presume that ventilation is affected by body structures. The results provide objective data for establishing the most suitable positions for stroke patients performing respiratory exercises.

Key words: Pulmonary function, Position, Change

(This article was submitted May 31, 2016, and was accepted Jul. 19, 2016)

INTRODUCTION

The posture of the body affects the distribution of ventilation and perfusion because of gravity and non-gravity factors in humans¹⁾, which induces a maximum air exchange depending on the gravity³⁾. Posture also affects the operation of the respiratory muscles by changing the length of the muscles, even though they stay stable²⁾. These changes are known to be influenced by the skeletal structure, the elasticity of the soft tissue around the thorax, and the power of the operating muscles in the respiratory system⁴⁾.

A number of studies have investigated the respiratory function of normal individuals in a supine position. For example, Townsend⁵⁾ stated that a reclining position causes blood congestion in the pulmonary blood vessels, as the abdominal organs put pressure on the diaphragm, pushing it toward the head, and the venous return increases; in this situation, lung volumes are relatively reduced. Allen et al.⁶⁾ reported that, in a reclining position, the amount of blood in systemic circulation, which moves to pulmonary circulation, increases. This scenario decreases the volume of the thorax, and abdominal contents press on the diaphragm, leading to labored breathing. When the respiration influenced by the activity of the rectus abdominis is measured, the pulmonary function is significantly improved in the sitting posture compared to the lying posture⁷⁾. Morgan et al.⁸⁾ noted that a reclining position weakens the back muscles, which subsequently reduces lung capacity. In addition, Song et al.⁹⁾ and Hong et al.¹⁰⁾ reported that normal individuals in a lying position showed an overall larger increase in lung capacity than those in a standing position. This finding indicates that pulmonary function is reduced due to changes in physical structures and the effects of gravity.

While considerable research has examined the effect of gravity on lung capacity in the lying posture, little research has compared the lung capacity of various lying postures. Therefore, this paper analyzes the lung capacity in various lying postures to obtain specific and objective data.

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SUBJECTS AND METHODS

The participants were 20 university students attending N University in Cheonan, Chungnam. The participants were selected from among those who had no particular history of lung diseases and smoking; had no accompanying damage, such as congenital deformation of the chest; and had not received any particular treatment to improve pulmonary functions. The participants understood the purpose of this study and consented to participate. This study was approved by the International Review Board of the Korea Nazarene University and was conducted in accordance with the ethical principles of the Declaration of Helsinki. Table 1 shows the general characteristics of group.

In this study, the participants lay down on a bed within a treatment room maintained at an average temperature of 20 °C. They relaxed to encourage expansion of the thorax and movement of the abdominal walls. A curtain was drawn over the participants to help them maintain psychological stability. The participants straightened out their legs on the bed and kept their head and trunk straight. After that, the participants changed their position to lie on the left side and their lung capacities were measured. After a five-minute break, they were measured again lying on the right side. If a participant complained of fatigue or dizziness during respiration measurement, a break was taken and the exercise resumed some time later. Prior to the measurement, the tester taught each participant the proper method for respiration measurement 2 or 3 times to ensure the participant was comfortable performing it¹¹.

Pulmonary function of the participants was measured in a sitting position using a tool called Fitmate (COSMED, Sri, Italy). To ensure accurate measurements, the tester explained and demonstrated the exercise to each participant beforehand. Experimental group was instructed to use the mouthpiece and to block the nostrils during the measurement so that air was neither inhaled nor exhaled through the nose. Starting from exhalation, the participants slowly exhaled to maximum level following the tester's signal and then slowly inhaled; volume capacity (VC) were measured at this time¹².

Data were analyzed using the SPSS Version 12.0 program for Windows. To compare and analyze chest mobility and pulmonary function in relation to position, one-way analysis of variance (ANOVA) was performed. For post-analysis, to show differences among the positions, Fisher's least significant difference (LSD) test was used. The statistical significance level, α , was chosen as 0.05.

RESULTS

We review the comparison of pulmonary function during maximal inspiration according to the four lying positions. Significant differences were found in VC before and after the experiment between supine and left side-lying positions, supine and right side-lying positions, supine and prone positions, and between left side-lying and prone positions ($p > 0.05$) (Table 2).

DISCUSSION

This study examined the effects of four lying positions on the lung capacity of 20 normal male and female university students in their twenties. The participants were asked to lie on their backs, right sides, left sides, and prone, and the changes to their lung capacity were measured to examine the pulmonary function in each posture. As lung capacity is a fundamental

Table 1. General participant characteristics

	Subjects (n=20)
Gender (M/F)	10/10
Age (years)	20.7 ± 3.2
Height (cm)	171.7 ± 9.2
Weight (kg)	65.8 ± 15.9

Values are means ± SD.

Table 2. Comparison of the pulmonary function measurement in the 20s subjects according to pillow height changes of position

	Position			
	Supine	Left sidelying	Right sidelying	Prone
VC(L)*abcd	4.38 ± 1.18	4.01 ± 1.11	4.16 ± 1.11	3.85 ± 1.10

Mean ± SE.

^asignificant difference between Supine and Left sidelying, ^bsignificant difference between Supine and Right sidelying, ^cSignificant difference between Supine and Prone, ^dSignificant difference between Left sidelying and Prone; VC: vital capacity

measure to evaluate respiratory function and it varies in each posture, for accurate evaluation of the respiratory function, it is necessary to compare the lung capacity according to postural changes^{13, 14}). Based on the standard suggested by Scot and Jan¹⁵), the lung capacity value was selected as the average of three time measurements. From the standardization of experimental participants, sufficient intervals between each posture is required⁵); thus, approximately 10 minutes were assigned to postural changes during the experiment. The measurements of the changes in lung capacity in the lying postures indicated that lung capacity is highest in the supine posture and lowest in the prone posture. The verification test of changes in lung capacity found a significant difference between lying supine and other lying postures, and a significant difference was also evident between left side-lying and lying in the prone position. When participants lay in the prone position, the top surface of the bed and the gravity disturbed the movement of the diaphragm, which directly affected the functionality of the thoracic wall and diaphragm and thus deteriorated the participants' ventilation. During inspiration, the contraction of the diaphragm and other muscles were disturbed; thus, a significant change was caused by the restricted increase of volume in the thoracic cage. As a result, the change in lung capacity was more remarkable when the participants lay supine compared to the other positions.

In the study by Kim et al.¹⁶), the postural change of obese participants affected the movement of the respiratory muscle, so that the change in the lung capacity was diversified in each posture. Lying on the side was disadvantageous for normal ventilation compared to lying on the back. Badr et al.¹⁷) measured the maximal expiratory flow rate and the respiration volume. These changes can be caused by the skeletal system, elasticity of the soft tissue around the thoracic cage, and the power of the muscle operating the respiratory system⁵). Morgan et al.⁹) noted that a reclining position weakens back muscles, which subsequently reduces lung capacity. He suggested the theory of abdominal activity that the gravity was supported by the abdominal muscles in the standing posture; meanwhile, the contraction of the diaphragm increases the movement of intercostal muscles. Song et al.⁹) reported that normal individuals in a lying position showed an overall larger increase in lung capacity than those in a standing position. In the study of Ko et al.¹⁸), the contraction of the diaphragm caused limited expansion in the volume of the thoracic cage and changed the volume around the abdomen, thereby decreasing the elasticity when the participants lay on their back because of the influence of gravity. The result of Ko's¹⁸) study of pulmonary function was similar to the result in this paper. Therefore, the result of the study suggested that lying on the back is the most efficient and stable posture for the respiratory function both in the clinic and everyday life in bed.

ACKNOWLEDGEMENT

This Research was supported by the Korean Nazarene University Research Grants 2016.

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