The Effect of Body Position on Pulmonary Function, Chest Wall Motion, and Discomfort in Young Healthy Participants

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Abstract

Objective: The purpose of this study was to investigate the effect of different recumbent positions on pulmonary function, chest wall motion, and feelings of discomfort in young nonobese healthy volunteers.

Methods: Twenty healthy volunteers (age, 28.0 ± 1.4 years; height, 167.5 ± 10.1 cm; weight, 62.3 ± 10.2 kg) were studied in the sitting position and in the following 6 recumbent positions: supine, left retroversion at a 45° tilt, left anteversion at a 45° tilt, right retroversion at a 45° tilt, right anteversion at a 45° tilt, and prone. After 5 minutes of a selected position, pulmonary functions, including vital capacity (VC), forced expiratory volume in 1 second, maximal inspiratory and expiratory mouth pressures (MIP and MEP, respectively), and breathing pattern components at the chest wall were assessed. Discomfort was assessed using a modified Borg scale.

Results: When participants changed position from sitting to each of the 6 recumbent positions, forced expiratory volume in 1 second values decreased significantly ($P < .05$). None of the participants showed changes in the MIP or MEP in any of the 6 recumbent positions. Rib cage motion was restricted in all recumbent positions except supine, left anteversion at a 45° tilt, and prone. In all 6 recumbent positions, discomfort was experienced during the pulmonary tests. However, in the left retroversion at a 45° tilt position, no discomfort was experienced during the MIP and MEP assessments.

Conclusion: In young, nonobese, healthy volunteers, recumbent positions caused diminished pulmonary functions and induced feelings of discomfort. (J Manipulative Physiol Ther 2014;37:719-725)

Key Indexing Terms: *Posture; Pulmonary Function Tests*

During pulmonary rehabilitation, changing the patient's position is one approach used to prevent dependent lung disease and disuse syndrome. The benefits of pulmonary rehabilitation programs in patients with chronic obstructive pulmonary disease (COPD) are well established.[1] Changing position combined with coughing and huffing is frequently used to promote secretion clearance.[2]

In the 1950s, the association between the mechanics of breathing and body position was shown by reports demonstrating that changes in body position resulted in considerable changes in the end-expiratory pressure, compliance, and mechanical resistance; these changes occurred despite similar respiratory rates and tidal volumes in the different body positions.[3–5] Changing position during spontaneous quiet breathing is known to affect not only thoracoabdominal kinetics but also gas exchange and the cardiovascular system.[6]

Studies of breathing in different positions have been conducted, with good results for patients; for example, that lateral decubitus impaired airway obstruction and lung diffusion in chronic heart failure (CHF)[7]; however, the participants were most often studied only in a seated position. In our hypothesis, some positions might worsen lung functions and generates discomfort feeling in even

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young healthy participants. In actual practice, successful pulmonary and cardiovascular rehabilitation has been achieved with the patient in a variety of positions, including recumbent. To date, there have been no reports describing whether patients experience psychological stress while in recumbent positions. Therefore, the purpose of this study was to investigate the influence body position on pulmonary function, chest wall motion, and feelings of discomfort in young, nonobese, healthy volunteers.

Methods

Participants and Postures

Twenty healthy volunteers (15 men and 5 women) the ages of 20 and 43 years (age, 28.0 ± 1.4 year) without obesity (height, 167.5 ± 10.1 cm; weight, 62.3 ± 10.2 kg; and body mass index, 22.2 ± 2.9 kg/m^2) agreed to participate in this study. They have had no history of heart diseases and respiratory tract diseases. This study was approved from the local ethics board and hospital administration at Hakuai Hospital, and all participants provided informed consent. All participants were assessed for pulmonary function, respiratory muscle strength, thoracic expansion difference, and subjective symptoms in 7 positions. All participants were examined in a sitting position and in the following 6 recumbent positions: supine, left retroversion at a 45° tilt (LR), left anteversion at a 45° tilt (LA), right retroversion at a 45° tilt (RR), right anteversion at a 45° tilt (RA), and prone. The first position tested was the sitting position, followed by the recumbent positions conducted in a random order.

Pulmonary Function Assessment

To assess pulmonary function, vital capacity (VC), forced VC (FVC), and forced expiratory volume in 1 second (FEV_1) were measured 3 consecutive times by using an electronic spirometer (Chest Co, Ltd, Tokyo, Japan). The highest value was recorded, according to the American Thoracic Society guideline.[8] Participants assumed each position for 5 minutes before any measurements were taken, after which measurements were recorded once per minute for an additional 5 minutes.

Respiratory Muscle Strength Assessment

Respiratory muscle strength was assessed by the maximal inspiratory and expiratory mouth pressures (MIP and MEP, respectively), based on the residual and total pulmonary capacity, respectively, using a breath dynamometer (Chest Co, Ltd).

Chest Wall Motion Assessment

To assess the thoracic expansion difference, we put a belt on the chest of the participant and then measured the tensile difference between the maximum exhalation and the maximum inspiration during total pulmonary capacity. The difference in thoracic expansion was assessed using computerized polysomnography (SomnoTracProSystem RESPITRACE QDC; Fukuda Denshi Co, Ltd, Tokyo, Japan) and expressed as the percentage of the expansion difference, with the value for the sitting position taken as 100%.

Discomfort Scale

We used a modified Borg scale[9] for evaluating feelings of discomfort during the pulmonary and respiratory muscle function tests.

Statistical Analysis

Data were analyzed using SPSS version 19.0 for Windows (SPSS, Chicago, IL). All assessments were analyzed using the Kruskal-Wallis test among positions and then using the Wilcoxon signed rank test between the sitting position and each of the recumbent positions, as any normality for distribution, which were analyzed by the Shapiro-Wilk test.[10] A post hoc power analysis demonstrated the ability to detect a 15% difference in the percent change in VC and FEV1 in the recumbent positions with those in the sitting position, with 98%. A probability value less than .05 was considered statistically significant.

Results

Pulmonary and Respiratory Muscle Function

Pulmonary function assessment showed that the mean values for the sitting position were higher than those for the recumbent positions (VC: 0.17-0.50 L and FEV_1: 0.34-0.46 L/s). Differences in the VC and FEV_1 among the data for each recumbent position were not statistically significant (1). Comparison of the percent change in VC and FEV_1 in the recumbent positions with those in the sitting position (defined as 100%) revealed that all the recumbent positions, except the supine and LR positions, showed a lower percent change in both the VC and FEV_1 (Fig 1). Respiratory muscle function assessment showed that the mean values in the sitting position were higher than those in the recumbent positions (MIP: 2.0-10.1 mm Hg and MEP: 0.3-7.6 mm Hg). Among the data for each position, no significant differences in MIP or MEP were observed (Table 1). In both numerical and relative values, there was no change in MIP and MEP in any position (Fig 1).

Chest Wall Motion

Thoracic expansion declined in all of recumbent positions compared with the sitting position (Fig 2). When participants changed from the sitting to supine