Effect of different body positioning on lung function variables among patients with bronchial asthma

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Abstract

Background: Bronchial asthma is often characterized by a significant reduction in lung function variables. Different postures correlate with patients' lung functions. The assessment of the lung function in different positions among asthmatic individuals might prove useful.

Aim of the Study: This study was carried out to investigate the effect of different body positions on lung function variables among patients with bronchial asthma.

Methods: The study design was a cross-sectional survey involving patients with bronchial asthma recruited from the Aminu Kano Teaching Hospital, Kano. A total of twenty patients participated, including 12 males and 8 females. Their lung function parameters (FEV_1, FVC and PEFR) were measured using a portable spirometer (MSO4) in different positions (sitting, standing, lateral decubitus and supine). Descriptive statistics of the mean and standard deviation, frequency and percentages were used to describe the anthropometric variables and inferential statistics of ANOVA were applied to compare the means of four different positions. The alpha level was set at $p<0.05$.

Results: The mean age, height and weight of the participants were 39.2±8 years, 63.3±9 kg and 1.64±0.1 m, respectively. There were significant differences in the lung function variables across all body positions ($p<0.05$). FEV_1 and FVC were found to be higher in the standing position compared to the sitting, supine and lateral decubitus positions. The values of FEV_1 and FVC were similar in the supine and lateral decubitus position ($p<0.05$). PEFR was significantly lower only in the supine position ($p<0.05$), as compared to the standing, sitting and lateral decubitus positions; its values in the standing, sitting and lateral decubitus were comparable ($p>0.05$).

Conclusion: FEV_1 and FVC were higher in the standing position compared to the sitting and supine positions.

Key words: bronchial asthma, lung function, body position, adults

Introduction

Asthma is an inflammatory disease of the small airways characterized by intermittent airway narrowing and obstruction that lead to the symptoms such as cough, shortness of breath, dyspnoea and sputum production [1]. The prevalence of bronchial asthma increased markedly in the last century and it now imposes a high disease burden on individuals, the healthcare system and the society [2]. Bronchial asthma is characterized by a significant reduction in lung function variables [3,4] and less effective ventilation with normal lung perfusion resulting in a ventilation/perfusion (V/Q) ratio of less than one [5].

Body posture has long been identified as a very important factor having an impact on lung volumes[6]. In addition, body positions are clinically important even in the healthy population because they are often used during treatment, resuscitation, everyday activities and surgical procedures [7]. Although the effective patient positioning may be associated with marked improvement in PaO2 and plays an important role in the conservative management of pulmonary dysfunction by reducing the effect of shunt or dead space, some positions may deteriorate V/Q matching [8].

It has been argued that routine side-to-side positioning should be avoided in most patients with respiratory diseases in favor of selective positioning based on the individual's needs and responses [9]. Moreover, relatively supine positions may be detrimental to asthmatics since such postures are known to reduce pulmonary sufficiency even in healthy individuals[10]. Alterations in body positions are also known to result in hydrostatic pressure changes, which affects both the systemic and pulmonary circulation [11].

The effects of various body positions on lung volumes and capacities of normal individuals have been previously reported to vary [5, 11, 12, 13]; in most of the cases more recumbent positions resulted in detrimental effects in different categories of patients [14]. It has also reported that as asthmatic subjects become more recumbent, the ability to generate the peak expiratory flow rate (PEFR) diminishes and conversely, as subjects move to less recumbent positions, the expiratory pressures and flow rates improve, yet the other lung functions have not been considered [14].

Generally, the supine position is mostly assumed as a comfort position by bronchial asthmatic patients. However, reduced lung volumes and flow rates and increased work of breathing have been reported even in healthy individuals. It is not widely known what effect the changes in body positioning will have on lung functions in patients with bronchial asthma. Hence, the present study.

Materials and methods

The target population comprised all patients diagnosed with and undergoing management for bronchial asthma using a bronchodilator (Salbutamol) in the respiratory clinic of the Aminu Kano Teaching Hospital, Kano. Twenty (20) asthmatic patients aged 30-60 years were recruited to participate in the study. The exclusion criteria included organ transplants, co-morbidities (hypertension, diabetes mellitus, hyperthyroidism), tobacco smoking, status asthmaticus, postural deformities such as scoliosis, chest wall deformities, and pregnancy. The mean duration of asthma was 28 years.

The ethical approval to conduct the study was sought and obtained from the ethical committee of the Aminu Kano Teaching Hospital. The nature of the study was clearly explained to the patients that were recruited after their consent had been obtained. Their anthropometric variables, such as height and weight, were measured. As far as the height is concerned, the subjects stood bare footed with the upper back, buttocks and heels against a height meter, the head was held in the erect position with the eyes looking forward in the Frankfort horizontal plane. The point of the greatest height of the head was taken and recorded in meters. The weight of patients was measured using a portable bathroom scale and recorded in kilograms. The BMI was calculated from the height and weight readings by dividing the weight (in kilograms) by the height squared (in square meters). Subsequently, the lung functions parameters (FEV1, FVC and PEFR) of participants were measured based on the American Thoracic Society (ATS) criteria in sitting, standing, supine and lateral decubitus positions.

The lung functions were measured using a micro-computerized spirometer (MS04, USA). All measurements were performed in accordance with the recommendations of the American Thoracic

Society (ATS) (1995), a minimum of three trials was obtained for each participant and the best reading of 3 trials was recorded for analysis. All the tests were carried out in a designated room in the morning hours (8am -9am). For the sitting posture, the participants were asked to adopt a comfortable sitting position on a stool; a treatment couch was used for lying positions. All participants started with the standing position, followed by the sitting, supine and lateral decubitus positions. A rest period of five minutes was observed between the individual positions. . Testing was terminated whenever the subject withdrew his/her consent, became short of breath, was too fatigued to continue, could not tolerate the position or was unable to perform the test correctly in that position.

Data Analysis

Descriptive statistics of the mean and standard deviation were used to summarize the anthropometric variables; frequency and percentages were used to summarize the gender demographics. Inferential statistics of ANOVA were applied to compare the mean differences in lung function variables across four different body positions (sitting, standing, supine and lateral decibitus). All analyses were performed using SPSS version 16.0 and the alpha level was set at $p<0.05$.

Results

The average age, weight and height of participants were 39.2±7.96 years, 63.3±8.96kg and 1.64±0.08m, respectively (Table 1). A total of twenty participants were recruited including 12 (60%) males and 8(40%) females.

Table 2 presents FEV_1, FVC and PEFR values across all four selected body positions. The analysis of one way ANOVA demonstrated a statistically significant difference (P= 0.000) in all lung function values across the body positions. More specifically, FEV_1, FVC and PEFR were significantly higher in the standing position compared to the lateral decubitus, and supine positions ($p<0.05$) ; moreover, FEV_1, and FVC were significantly lower in the sitting position compared to the standing position ($p< 0.05$). PEFR was comparable in the sitting and standing position ($p>0.05$). The results also revealed that FEV_1 and FVC were comparable in the lateral decubitus and supine positions ($p>0.05$); otherwise, PEFR was significantly higher in the lateral decubitus position compared to the supine position ($p<0.05$) and comparable in the sitting and standing positions ($p>0.05$).

Discussion

This study was conducted to investigate the effect of different body positioning on lung functions among asthmatic patients. The participants were mostly middle-aged individuals; the average age being 39 years. Their relatively young age also suggests that asthma cuts across all age groups. The average weight and height of participants were optimal for the age group under survey and they further validated the study outcomes in terms of applicability.

The study results demonstrated significant changes in lung function variables across body positions. Generally, the lung function variables decreased as the subjects became more recumbent and the highest FVC and FEV_1 were observed in the standing position, which is consistent with the data reported in literature where a significant decrease in FEV1 was found when the sitting position was changed into each of the 6 recumbent positions and the higher lung function was observed in the standing position[10, [14, 15]. Another reason of the above findings may be due to an increase in thoracic cavity volume [14] and the effect of gravity on the abdominal contents caudally within the abdominal cavity, thereby increasing the vertical diameter of the thorax [16] and/or the allowance that is present in the inspiratory muscles, enabling them to expand the unrestricted thorax in all directions [19]. Moreover, our findings showed comparable $FEV_{1,}$ FVC in the lateral decubitus and supine positions. The major factor responsible for the low arousal level is often associated with recumbent positions and effects of gravity [14]. Similar findings were reported for the normal population [18] as the lateral decubitus position is characterized by the abdominal contents moving forward thereby placing the abdominal muscles at a better length (compared with the supine position). Incidentally, the base of the lungs is not compressed by the weight of the heart and abdominal contents in lying positions, which may account for the similarities seen.

No significant differences in PEFR values were observed in the sitting, standing and lateral decubitus positions. This may be due to the fact that PEFR is a factor of speed while FEV_1 and FVC are the factors of volume, and the obstructive nature of bronchial asthma affects mainly the volume of the lungs. Generally, according to our results as the subjects became more recumbent,, the ability to generate higher lung functions diminished, which was reported earlier[14]. Conversely, as the subjects moved to less recumbent positions, the expiratory pressures and flow rates improved. Although the results showed similar PEFR values for all the positions except the supine one, PEFR is also known to be assisted by elastic recoil of the lungs and chest wall [19], which is likely to explain the above results.

Moreover, the study results demonstrated that sitting led to the second highest lung function after standing. The above may be caused to the effect of the sitting position on the abdominal cavity which interferes more with the diaphragmatic motion, as compared to the standing position. The literature data concerning this subject are sparse despite its importance for physiotherapy. Our findings can serve as a treatment guide for patient self-management as well as education; moreover, they can be used during the administration of breathing exercises. Further research may look into the effect of positions on the other outcomes such as the frequency of hospital visits, duration of hospital visits and frequency of attacks.

Conclusion

FEV_1 and FVC were found to be higher in the standing position compared to the sitting and recumbent positions. Lower PEFR values were observed among individuals with bronchial asthma in the supine position.

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Table 1. Anthropometric characteristics of participants

Variables	M±SD	95% CI
Age	39.2±7.96	32-43
Weight	63.3±8.96 kg	58-65
Height	1.64±0.08m	1.50-1.90

SD=standard deviation, n=frequency, %= percentage

Table 2. Changes in lung function across four different positions

VARIABLE	Sitting M±SD	Standing M±SD	Supine M±SD	Lateral decubitus M±SD	P-value
FEV_1 (Litre)	1.98±0.28[a]	2.31±0.68[b]	1.52±0.23[c]	1.74±0.24[c]	0.000*
FVC (Litre)	3.07±0.29[a]	3.35±0.31[b]	2.60±0.30[c]	2.82±0.27[c]	0.000*
PEFR (L/min)	334.15±35.4[a]	351.9±35.1[a]	284.30±25.3[b]	310.40±28.60[a]	0.000*

Key: *Significant at 0.05 alpha level, =, M±SD= mean and standard deviation, the same superscript means no significant difference while different superscripts mean significant difference

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