A Comparison of Lung Functions between Supine, Comfortable Sleeping Positions and Uncomfortable Sleeping Positions in Adult Males

MVG Pinto[1], Anula Kariyawasam[2], Bhagya Thenuwara[3], Prabuddha VB Jayasinghe[3], Sasika K Weerabahu[3], Senani U Dunukearachchi[3], Dhanoja LR Wijesinghe[3], AHMAH Abayasinghe[3]

[1] Senior Lecturer, Department of Anaesthesiology, Faculty of Medicine, University of Peradeniya, Peradeniya, Sri Lanka
[2] Senior Lecturer, Department of Physiology, Faculty of Medicine, University of Peradeniya, Peradeniya, Sri Lanka
[3] Temporary Lecturer, Department of Anaesthesiology, University of Peradeniya, Peradeniya, Sri Lanka.

***Abstract*- Introduction:** There are areas of the lung which have differences of ventilation and perfusion and certainly there are different degrees of ventilation and perfusion matches and mismatches, which can contribute to the final outcome of oxygenation [(1)]. The lung functions can change by the position [(2)]. It is a known fact that an individual adapts different positions to sleep [(3)]. This probably may be related to the most well ventilated areas and probably the best matched perfusion as well. Finding this relationship might have importance in clinical practice to improve oxygenation in respiratory compromised patients.

Methods: This study was designed to detect whether the lung functions are changed by adopting the patient's normal sleeping posture including the body, head and arm positions. The study was carried out at the Faculty of Medicine, University of Peradeniya as a descriptive cross sectional study including 30 consenting male medical students in 20 – 25 years age group. The subjects suffering from asthma, COPD, acute lung infections or any chest deformity were excluded. Spontaneous Tidal Volume (STV), Forced Vital capacity (FVC), were measured in supine position and after adopting their most comfortable sleeping posture with body, head and arm position and uncomfortable sleeping posture.

Results: Mean age, height, weight and BMI of the sample did not show significant difference. Paired t test was used to analyze the lung functions in all three positions. With regard to STV and FVC there was a significant difference between the supine and most comfortable sleeping positions (p value p-0.0355and p-0.034 respectively). The Tidal volumes observed in Supine and uncomfortable positions were again significantly different. P - 0.0341($p<0.05$)

The comfortable and uncomfortable positions varied with a non-significance to the tidal volume 0 .302 but significance to the vital capacity 0.007

Conclusions: Lung functions are improved by adopting the individual's most comfortable sleeping position compared to supine and uncomfortable sleeping positions. It should be possible to use this in clinical practice to improve oxygenation in respiratory compromised patients.

***Index Terms*-** Lung functions, Supine Position, Most Comfortable sleeping position

I. Introduction

In humans there are differences of ventilation in different areas of the lung which can be further changed by body position [(1).] This is same with perfusion as well, thus different ventilation and perfusion (V/Q) ratios will ultimately have an impact on arterial oxygenation. Various observers have noted the influence of posture on certain lung volume measurements, such as vital capacity, expiratory reserve and functional residual capacity [(2)]. Most of these studies have being carried out involving the supine and sitting positions.

For some reason, it is very obvious that an individual adapts different sleeping positions which explained in the literature as Foetus, Log, Yearner, Soldier, Free faller and Starfish [(3)].It is a possibility they may be adapting their individualized sleeping position in relation to the best locations of the most well ventilated areas of the lung, or to match their best ventilation to perfusion.

Finding evidence for this hypothesis will be valuable since this can be used in clinical practice to improve oxygenation in patients. Also this can be studied further and applied to patients with respiratory compromise as well.

It is evident in the existing literature, lung functions are improved by adapting an individual's most comfortable sleeping position including their head and arm position [(3)]. As a further extension to this finding we conducted the second study to compare lung functions between supine, comfortable and uncomfortable sleeping positions in an analogous group of adult males.

II. Objectives

Broad objective

To evaluate the association between different sleeping positions and changes in lung functions.

Specific objectives

1. To evaluate the association between the changes occurring in lung functions in the supine position and in the comfortable sleeping positions.
2. To evaluate the association between the changes occurring in lung functions in the supine position and in the uncomfortable sleeping positions.

3. To evaluate the association between the changes occurring in lung functions in comfortable sleeping positions and in uncomfortable sleeping positions.

III. Methodology

The study was carried out as a descriptive cross sectional study at The Faculty of Medicine, University of Peradeniya including 30 consenting male medical students in 20 – 25 years age group. The exclusion criteria were any long standing or acute respiratory diseases, smoking or anatomical defects of the chest. The study was carried out using a researcher administrated pre tested data sheet which includes age, height, weight and their normal sleeping position. Sleeping positions which were identified as the most comfortable sleeping positions were depicted using pictures in the data sheet with head and arm positions. The Spontaneous Tidal Volume (STV) and Forced Vital Capacity (FVC) were measured in the subjects using the electronic spirometer in the supine posture and after adapting their normal most comfortable sleeping position with head and arm position. Each subject was kept in that position for 5 minutes before recording their lung functions. Then the subject was asked to maintain their most uncomfortable sleeping position freely selected by them for 5 minutes and same parameters were measured.

The data were recorded and analyzed by paired t test using SPSS statistical software (13^{th} version). Results were expressed as mean ± Standard Deviation and the difference of mean values was considered significant when they obtained P value was <0.05.

Ethics committee approval was obtained for the research.

IV. Results

The age and anthropometric data were presented in table 1

Table 1: Age and Anthropometric Data

	Mean ± SD	Range	
Age (Years)	22.43 ± 1.382	20	25
Body weight (kg)	58.570± 9.0203	42	84
Height (cm)	168.450± 7.1019	155	177
BMI (kg per m^2)	20.6369 ± 2.61175	14.90	30.12

Table 2: Percentages of Most comfortable Sleeping Positions

Sleeping position	Percentage (%)
Prone- head turned laterally and arms flexed at elbows	20.00
Supine- arms straight and flexed	10.00
Supine- arms straight and flexed recumbent	30.00
Right Lateral- arms straight and flexed/ recumbent	33.33
Left Lateral- arms straight and flexed/ recumbent	06.67

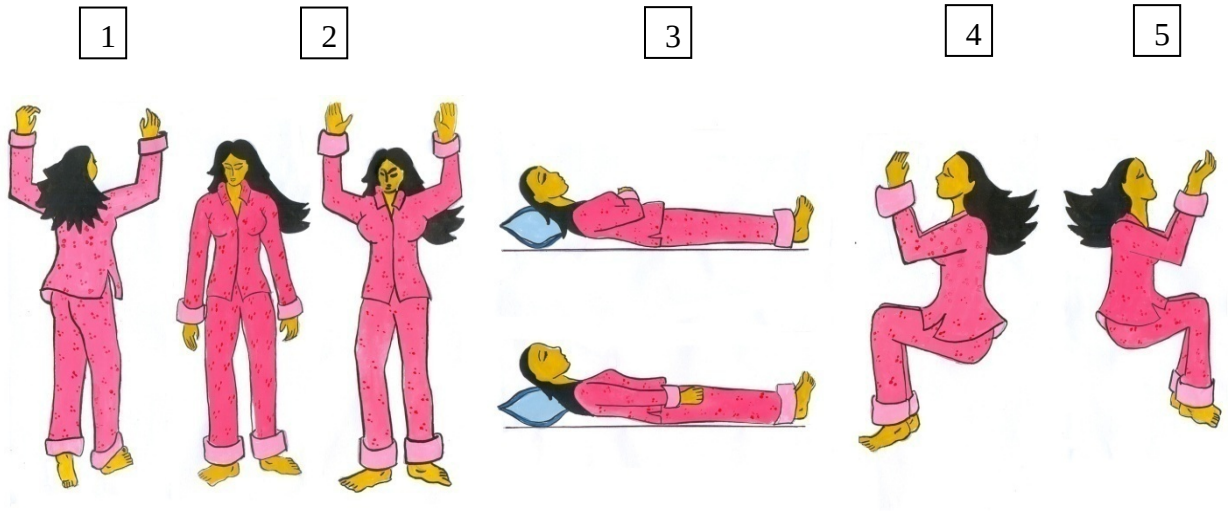

Figure 1: Identified most comfortable sleeping positions

01. Prone- head turned laterally and arms flexed at elbows
02. Supine- arms straight or flexed
03. Supine- arms straight or flexed recumbent
04. Right Lateral- arms straight or flexed/ recumbent
05. Left Lateral- arms straight or flexed/ recumbent

The different sleeping positions observed in the subjects were supine with arms straight and flexed with internal rotation at elbows, prone with head turned laterally and arms flexed at elbows, right lateral and left lateral with arms straight and flexed with internal rotation at elbows and right lateral and left lateral recumbent (Table 2)

Table 3: TV, VC and FVC in Supine, Comfortable & Uncomfortable Sleeping Positions.

	N*	Range	Mean L	Standard Deviation
Supine TV†	28	1.21	0.5979	.29263
Comfortable TV	28	.94	0. 7976	.26740
Uncomfortable TV	28	32.98	0.7507	6.15031
Supine VC ‡	28	3.80	4.7004	.97552
Comfortable FVC §	28	4.34	4.8861	.99416
Uncomfortable FVC	28	4.40	4.2083	1.40038

*Number †Tidal Volume ‡Vital Capacity §Forced Vital Capacity

The mean STV detected was 0.5979 L in supine position whereas in most comfortable sleeping position with arm position it was increased to 0.7976(Table 3). There was a significant difference between the two positions with respect to STV. (P = 0 .036)

The FVC was increased from 4.7004 L to 4.8861L when the subject's position was changed from supine to normal comfortable sleeping position with arm position (Table 3). A significant difference was evident between supine position and after adapting the most comfortable sleeping position in the same subject. (p = 0.034)

Table 4: Statistical Analysis of Supine and Uncomfortable Vital Capacity

Sleeping position	N*	Mean	Standard Deviation	t†	95% Confidence Interval of the Difference		Significance (2-tailed)
					Lower	Upper	
Supine VC ‡	28	4.7004	.91711	3.281	0.24898	1.08054	0.003
Uncomfortable VC	28	4.2083	1.40038				

*Number † t value ‡Vital Capacity degree of freedom=27

The observed Vital capacities were significantly different in both positions. P-0.003($p<0.05$) (Table 4)

Table 5: Statistical analysis of most comfortable and uncomfortable Tidal Volumes

Sleeping position	N*	Mean	Standard Deviation	t†	95% Confidence Interval of the Difference		Significance (2-tailed)
					Lower	Upper	
Most Comfortable TV‡	28	4.7004	0.26192	1.052	-3.61896	1.16539	0.302
Uncomfortable TV	28	4.2083	6.15031				

*Number † t value ‡ Tidal Volume degree of freedom=27

Table 6: Statistical analysis of most comfortable and uncomfortable Vital Capacity

Sleeping position	N*	Mean	Standard Deviation	t†	95% Confidence Interval of the Difference		Significance (2-tailed)
					Lower	Upper	
Most Comfortable VC‡	28	4.8861	0.94128	2.617	0.13222	1.09171	0.014
Uncomfortable VC	28	4.2083	1.40038				

*Number †t value ‡Vital Capacity degree of freedom=27

V. Discussion

There was a significant difference found between the supine position and the most comfortable sleeping positions with respect to STV (Table 3). As described in previous study [3] rice in the volumes with the adaptation of the most comfortable sleeping positions was noted. (Table 3)

Even though the pattern of changes occurred in lung volumes was the same as the previous study [3], the values noted were different. This probably may be due to the finding that a higher percentage has chosen supine position with the recumbent position as the most comfortable sleeping position in this study (30%) compared to the literature [3]. Also the results could have been affected by the fact that a considerable amount of subjects (10%) have selected supine without recumbent, as their most comfortable sleeping position (Table 2). To comment more on this, different positions could have been analyzed individually with the supine position.

Considering the vital capacity it was clearly seen that the volume is high in supine position compared to the uncomfortable sleeping position with a significant difference (Table 5)

The important finding of this study was detected when the Tidal and Vital capacity of the most comfortable sleeping position were compared with the lung volumes of uncomfortable positions. It was clearly shown that the volumes were more with the comfortable than the uncomfortable position. But the statistical significance only could found with the Vital Capacity. (Table 6)

There is existing literature depicting changes of Vital Capacity (VC), Expiratory Reserve Volume (ERV) and Functional Residual Capacity (FRC) with the supine to sitting posture. These changes were explained by the changes of flow rates with the change in posture from sitting to horizontal position causing a decrease in effort dependent inspiratory and expiratory flow rates, which is related to the smaller diameter of the oro-pharyngeal airways in supine than in sitting posture. Thus the change in effort dependent maximum inspiratory and expiratory flow rates could be related to the increase in the resistance of upper airways on assuming horizontal postures [1], [4]. This application might be having some relevance to our finding as well. Also in existing evidence, Oxygen saturation and FRC were found to be significantly higher in the prone position [5] which can be explained by the alteration in diaphragmatic mechanics, improved drainage of secretions and reduction of intra pulmonary shunting [1].

Our study results indicate that by adapting an individual's most comfortable sleeping position with head and arm position brings a significant improvement of their lung volumes when compared to supine posture and uncomfortable sleeping positions. This observation proved the hypothesis tested.

Based on the findings here adapting individuals most comfortable sleeping positions have contributed to the increase in their lung volumes significantly. This needs to be studied more for the improvement of oxygenation, since the location of the highly or less ventilated areas of the lung and there matching to the perfusion can contribute greatly to the oxygenation.
Identifying these areas in each individual may be difficult needing sophisticated lung function tests. Application of these principles for the management of respiratory compromised patients and for ventilating them in the critical care setting would be a sensible mission.

VI. Conclusion

Lung functions are improved by adapting the most comfortable sleeping position with head and arm position of an individual in comparison to the supine and uncomfortable sleeping positions. Positions selected by each individual probably have a greater degree of ventilation and perfusion matching.

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AUTHORS

First Author – Author name, qualifications, associated institute
First Author – MVG Pinto, Department of Anaesthesiology, Faculty of Medicine, University of Peradeniya, Sri Lanka. vasantipinto@yahoo.com
Second Author – Anula Kariyawasam, Department of Physiology, Faculty of Medicine, University of Peradeniya, Sri Lanka., tashiya2004@yahoo.com
Third Author – Bhagya Thenuwara, Department of Anaesthesiology, University of Peradeniya, Sri Lanka, thenuwarabhagya@gmail.com
Fourth Author – Prabuddha VB Jayasinghe, Department of Anaesthesiology, University of Peradeniya, Sri Lanka, Prabu.bear@gmail.com
Fifth Author – Sasika K Weerabahu, Department of Anaesthesiology, University of Peradeniya, Sri Lanka, sasikaviraj@gmail.com
Sixth Author – Senani U Dunukearachchi, Department of Anaesthesiology, University of Peradeniya, Sri Lanka, senaniupamalika@yahoo.com
Seventh Author – Dhanoja LR Wijesinghe, Department of Anaesthesiology, University of Peradeniya, Sri Lanka, dhanojawijesinghe@gmail.com
Eighth Author – AHMAH Abayasinghe, Department of Anaesthesiology, University of Peradeniya, Sri Lanka, anjaabey@gmail.com