Journal of Advance Researches in Biological Sciences, 2011, 3 (2) 121-127

EFFECT OF RECUMBENT BODY POSTURE ON DYNAMIC LUNG FUNCTION IN YOUNG HEALTHY NON OBESE SUBJECTS

Patil Satish G.[1], **Kulkarni Chandrahas M.**[2], **Sorganvi Vijaya.M.**[3], **Dhanakshirur Gopal D.**[4], **Aithal Manjunatha** [5]

[1,2,4,5]Department of Physiology, [3]Department of Community Medicince, Sri B.M.Patil Medical College & Research Centre, BLDE University, Bijapur

Submitted on : - 21/01/2011 *Resubmitted on :- 20/02/2011* *Accepted on:- 30/03/2011*

Abstract

Sleeping position affects upper airway morphology, which in turn may affect respiratory function. Postural changes in lung volume, in the transverse plane in the healthy individuals are not well documented. The purpose of the present study is to assess the effect of recumbent body posture in relation to head position on dynamic lung function in healthy non obese subjects. This study was carried out on 21 male healthy subjects with age of 19.4 ± 1.2 years (Mean ± SD) and mean body mass index of 21.45 ± 2.37 Kg/M^2. Dynamic lung function tests was performed in six recumbent positions, (1)Supine with head straight (SUPHS) (2)Supine with head rotated to the right (SUPHR) (3) Supine with head rotated to the left (SUPHL) (4) Right lateral recumbent body position (5) Left lateral recumbent body position (6) Prone position. We observed a significant increase in mean PIF ($p<0.05$) in right lateral recumbent posture and mean PIF ($p<0.02$) in left lateral recumbent posture compared with SUPHS. There were no significant changes in lung function on head rotation. A statistically significant decrease in mean FVC ($p<0.008$), FEV0.5 ($p<0.001$), FEV1 ($p<0.001$), PEF ($p<0.003$), Vmax 25% ($p<0.003$), Vmax 50% ($p<0.05$) in prone position compared with SUPHS, but there was no significant changes in PIF, FEF, and FET 100%. Hence we conclude from the present study, that change in posture in transverse plane induces change in lung function. Head rotation may induce changes in upper airway morphology but could not affect lung function in healthy individuals.

Key words: Recumbent body posture, Head position, dynamic lung function.

Introduction

Sleeping position affects upper airway morphology, which in turn may affect respiratory function. Studies have confirmed that in normal awake subjects, oropharyngeal passage of airways have a smaller diameter in lying than in sitting posture and also have smaller diameter in supine posture compared to lateral recumbent posture (LRL)[1,2]. In patients who snore and who exhibit hypopnea and obstructive sleep apnea (OSA), symptoms are more common when lying down than when sitting and are also more common when lying supine than when in a lateral recumbent position[3,4].

The change in head position during sleep also affects upper airway function[1,2,5]. Studies have shown that changes in the head position in the sagittal dimension, that is, flexion and extension of the neck, and in horizontal dimension, that is, head rotation to the right or left affects upper airway function[6,7]. It has been demonstrated that head rotation alters the timing and pattern of infant tidal breathing[8]. Recent studies speculated that changes in lung volume might occur in association with postural changes in the transverse plane and this change in lung volume may play a important role in pathomechanism of OSA and central sleep apnea (CSA)[9]. Postural changes in lung volume in the transverse plane are not well documented. The purpose of the present study is to assess the effect of recumbent body posture in relation to head position on dynamic lung function in healthy non obese subjects.

Material and Methods

The present study was carried out on 21 male healthy subjects with age of 19.4 ± 1.2 years (Mean ± SD) and mean

Corresponding Author :

Dr. Satish. G. Patil

Department of Physiology

Sri.B.M.Patil Medical College & Research Centre

BLDE University, Bijapur-586101, Karnataka (India)

body mass index of 21.45 ± 2.37 Kg/M^2. Subjects with body mass index more than 30, subjects with ongoing respiratory disorders or infections, subjects with past history of chronic illness, subjects with history of respiratory infection in the last six weeks and subjects taking medication for any purpose were excluded from the study. Informed consent was obtained from each subject before the study.

Dynamic Lung Function Test : Dynamic lung function test (DLFT) was performed with computerized Spirometer (Spiroexcel, Medicaid Labs, Chandigarh, India). The following parameters were included in the study- Forced vital capacity (FVC), Forced expiratory volume in first 0.5 second (FEV0.5), Forced expiratory volume in first second (FEV1), FEV/FVC%, Peak expiratory flow rate (PEF), Peak inspiratory flow rate(PIF), flow rates at 25%, 50% and 75% lung of FVC (Vmax 25%, Vmax 75%, and Vmax100%), and forced expiratory time (FET).

Protocol : DLFT recordings were made in six body and head positions in each subject: (1) Supine with head straight (SUPHS) (2) Supine with head rotated to the right (SUPHR) (3) Supine with head rotated to the left (SUPHL) (4) Right lateral recumbent body position (5) Left lateral recumbent body position (6) Prone position.

In supine position, head was kept straight by using pillow. In supine position with head rotated, the subject was instructed to rotate his head (to right and left) as much as possible without overstraining or producing discomfort. In the lateral recumbent body position, the subject lay on his right or left side, and using pillow, held his head in line with the trunk. In the prone position, the head was facing towards right side and kept straight. In each position, after taking a rest for five minutes, DLFT were recorded. The subject was asked to take maximum inspiration, then with closed nostrils, breath out forcefully and smoothly in the mouth piece of an instrument, followed by maximum inspiration. The maneuver was repeated for three times. The maximum value among the three maneuvers was considered. FVC and flow rates were calculated from the flow volume curve obtained.

Statistical analysis : All the parameters were expressed as mean value ± standard deviation (SD). A comparison was made between SUPHS and SUPHR, SUPHS and SUPHL, SUPHS and RLR posture, SUPHS and LLR, SUPHS and prone. A 1-way, repeated analysis of variance was applied to investigate significant differences between the postures. Paired't' test was applied to determine the level of statistical significance. Statistical significance was established at $p < 0.05$.[10,11]

Results

We observed a significant increase in mean PIF ($p<0.05$) in right lateral recumbent posture and mean PIF ($p<0.02$) in left lateral recumbent posture when compared with SUPHS. An increase in FVC is also observed in lateral recumbent postures when compared with supine. There was no significant difference in FEV0.5, FEV1, FEV/FVC%, PEF, Vmax 25%, Vmax 75%, Vmax100% and FET. (Fig-1and 2)

We have not found any significant difference in FVC and flow rates between SUPHS and supine with head rotated to right or left. (Table-1and 2)

Fig-3 shows a statistically significant decrease in mean FVC ($p<0.008$), FEV0.5 ($p<0.001$), FEV1 ($p<0.001$), PEF ($p<0.003$), Vmax 25% ($p<0.003$), Vmax 50% ($p<0.05$) in prone position compared with SUPHS, but there was no significant difference in PIF and FET 100%.

Discussion

Flow volume curve is a graphic plot that provides useful information about the lung function and the relationship between lung volume and maximal rate of airflow. This is achieved during inspiration and expiration using maximum effort against relevant lung volumes.

Supine and lateral recumbent posture (LRP) : Many researchers have examined changes in lung volume, when subjects move from an upright to a supine position but little is known when subjects move from supine to LRP. A.Talwar et al found significant decrease in FVC, FEV0.5, PEF, FEF50, PIF, FIF 50 in supine and LRP when compared with the sitting position, but no significant difference was observed among the supine, right lateral recumbent and left lateral recumbent posture[12]. In our study, we have observed a significant increase in mean PIF ($p<0.05$) in right lateral recumbent posture and mean PIF ($p<0.02$) in left lateral recumbent posture when compared with supine position.

Table-1: Dynamic lung function test in supine with head straight posture and supine with head rotated to right side.

	SUP^{HS}	SUR^{HR}	p-Value
FVC (L)	3.67 ± 0.33	3.69 ± 0.31	0.844^{NS}
FEV0.5 (L)	2.47 ± 0.2	2.45 ± 0.23	0.89^{NS}
FEV1 (L)	3.3 ± 0.24	3.31 ± 0.27	0.602^{NS}
FEV1 / FVC%	89.29 ± 4.83	89.3 ± 5.52	0.736^{NS}
PEF (L/S)	8.42 ± 1.2	8.26 ± 1.3	0.396^{NS}
PIF (L/S)	5.08 ± 1.75	5.43 ± 1.84	0.306^{NS}
FEF 25-75%	5.28 ± 0.85	5.22 ± 0.86	0.946^{NS}
Vmax 25%	8.26 ± 1.18	8.07 ± 1.29	NS
Vmax 50%	6.15 ± 1.06	6.03 ± 1.1	0.877^{NS}
Vmax 75%	2.72 ± 0.59	2.74 ± 0.65	0.646^{NS}
FET 100%	2.38 ± 0.8	2.01 ± 0.68	0.768^{NS}

Data presented are mean±SD. *p<0.05, **p<0.01, ***p<0.001; NS: Not significant.

SUP^{HS}: Supine with head straight; SUP^{HR}: Supine with head rotated to right side;

Table-2 : Dynamic lung function test in supine with head straight posture and supine with head rotated to left side.

	SUP^{HS}	SUR^{HR}	p-Value
FVC (L)	3.67 ± 0.33	3.66 ± 0.35	0.717^{NS}
FEV0.5 (L)	2.47 ± 0.2	2.39 ± 0.19	0.372^{NS}
FEV1 (L)	3.3 ± 0.24	3.24 ± 0.27	0.295^{NS}
FEV1 / FVC%	89.29 ± 4.83	88.59 ± 4.89	0.823^{NS}
PEF (L/S)	8.42 ± 1.2	8.07 ± 1	0.198^{NS}
PIF (L/S)	5.08 ± 1.75	5.45 ± 1.72	0.279^{NS}
FEF 25-75%	5.28 ± 0.85	5.08 ± 0.82	0.483^{NS}
Vmax 25%	8.26 ± 1.18	7.89 ± 1	0.235^{NS}
Vmax 50%	6.15 ± 1.06	5.92 ± 1.03	0.601^{NS}
Vmax 75%	2.72 ± 0.59	2.68 ± 0.64	0.444^{NS}
FET 100%	2.38 ± 0.8	2.41 + 0.71	0.502^{NS}

Data presented are mean±SD. *p<0.05, **p<0.01, ***p<0.001; NS: Not significant.

SUP^{HS}: Supine with head straight; SUP^{HL}: Supine with head rotated to left side.

PIF depends on upper airway patency, internal lung recoil resistance and inspiratory muscle strength. Pevernagie et.al studied the influence of changes in the direction of the gravitational pull on upper airway structures in patients with OSA. They demonstrated that subjects with positional OSA (patients in whom the rate of apnea and hypopnea during sleep in the supine position was two or more times greater than the rate in the lateral position) had a greater transverse upper air way diameter in LRP than did subjects with non-positional OSA[13]. Otsuka et al found significant decreases in both phasic and tonic genioglossus EMG activity when subjects moved from supine to LRP[7]. Although we have not studied the morphological changes in upper airway, but our findings, that is, change in PIF can be correlated to change in upper airway diameter in LRP. Therefore in LRP, PIF might be increased due to greater upper air way diameter when compared to supine position. Another possible explanation is that, there may be less gravitational effect on inspiratory muscles in LRP, which facilitates PIF. It has been reported that both OSA and CSA are decreased during microgravity[14].

We have also observed a small increase in mean FVC in both right LRP and left LRP when compared with supine position. Hurewitz et al found an increase in FRC (functional residual capacity) of approximately 560ml in LRP when compared with the supine position in the non obese healthy subjects. However, the numbers were small (n=3) and generalizations thus difficult to make. We have not assessed FRC in our study[15]. Pump et al reported that in healthy subjects, the left lateral posture increases left atrial diameter, facilitates venous return and decreases mean systemic arterial pressure[16]. Increased venous return from lungs into the left atria decreases intrathoracic blood volume and thus increases lung volume.

Supine with head straight and head rotation

We were also interested in assessing the effect of head rotation in supine position on dynamic lung function, as it was reported that neck position may alter the longitudinal tension on the trachea causing tracheal stiffness, which may affect expiratory flow rates[17]. Otsuka et al found significant decreases in both phasic and tonic genioglossus EMG activity on head rotation[7]. However, in our studies we could not find significant difference in dynamic lung function between SUPHS and supine with head rotated to right or left.

Supine and prone posture:

Xiao-mingshen et al measured and documented significant reduction in crying vital capacity and PEF in the prone when compared with supine position[18]. We have also observed a statistically significant reduction in the mean FVC ($p<0.008$), FEV0.5 ($p<0.001$), FEV1 ($p<0.001$), PEF ($p<0.003$), Vmax 25% ($p<0.003$), Vmax 50% ($p<0.05$) in the prone compared with the supine position.(Vide Fig-1) we believe that the pressure on the abdomen as well as on the chest in prone posture may decrease the expansion of chest and reduce lung volume and flow rates.

Conclusion

This study has shown significant postural changes in lung volume and flow rates. A significant increase in PIF was observed in LRP when compared with supine. This increase in PIF is attributed to greater upper airway diameter, less gravitational effect and decrease in intrathoracic blood volume in LRP when compared with supine.

There was no significant difference in lung function on head rotation. Head rotation may induce changes in upper airway morphology but could not affect lung function in healthy individuals. A significant reduction in the FVC and flow rates in prone when compared with supine was observed.

As we have not studied postural changes in the upper airway dimensions, so to correlate and to derive the definite conclusion, postural changes in upper air way dimensions and lung function should be studied in the same subjects. Further studies are needed to be conducted to find out factors influencing flow rates and lung volume in the lateral recumbent posture.

Fig 1: Showing comparison of dynamic lung function test between supine with head straight and right lateral recumbent posture.

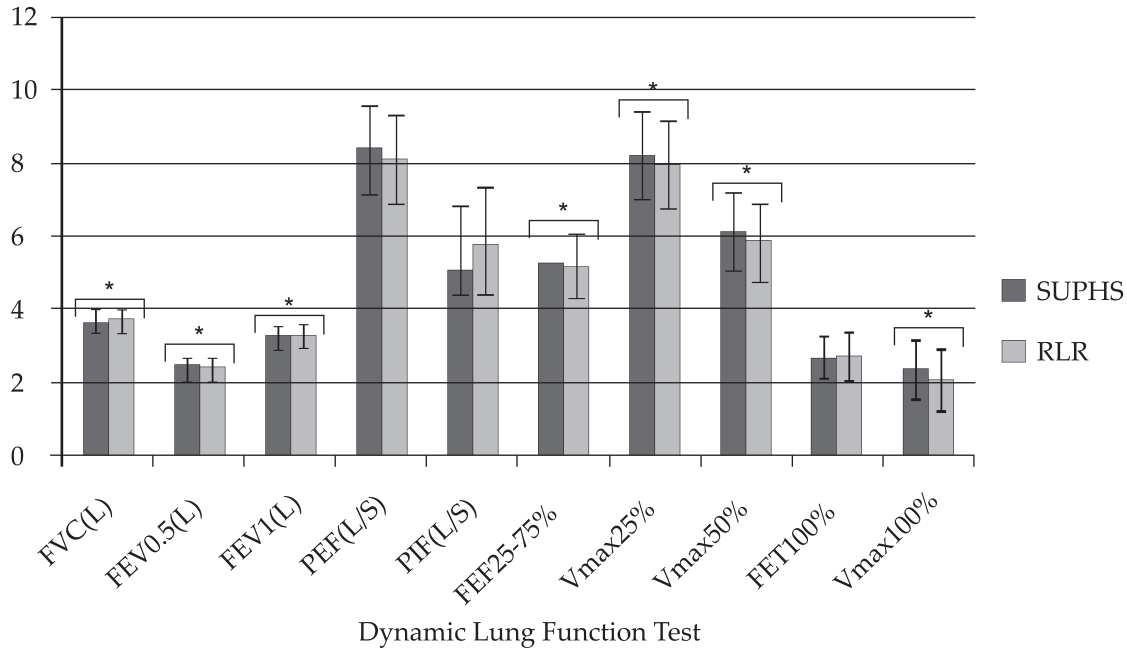


Fig 2: Showing comparison of dynamic lung function test between supine with head straight and left lateral recumbent posture.

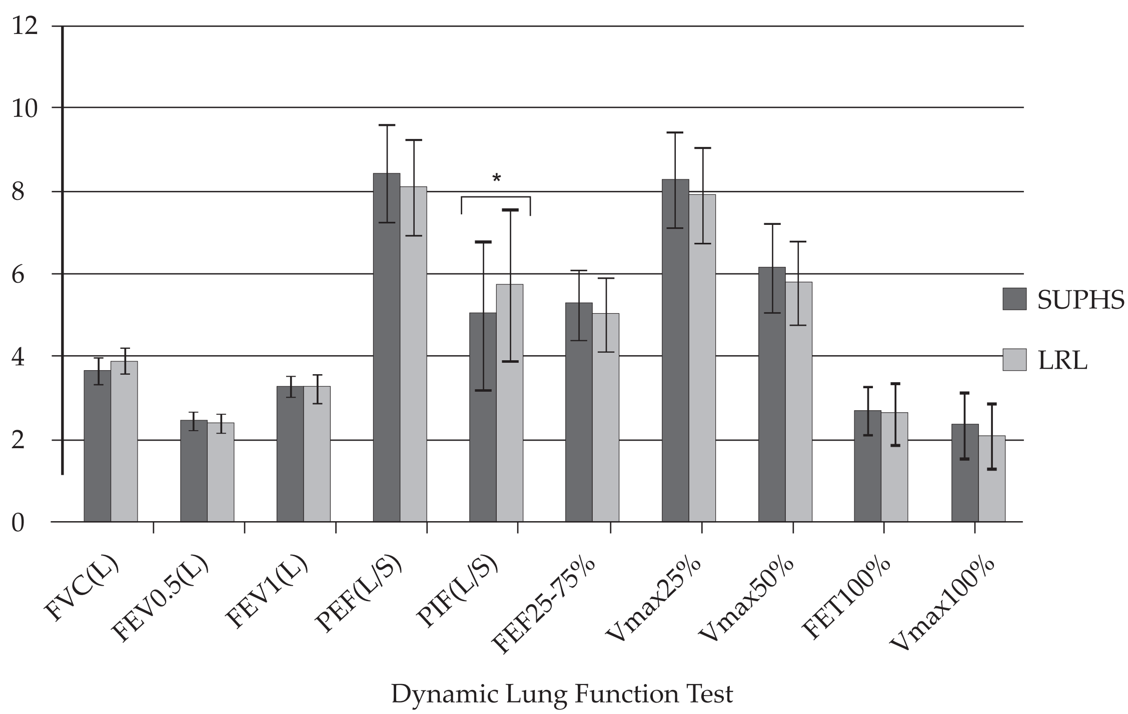
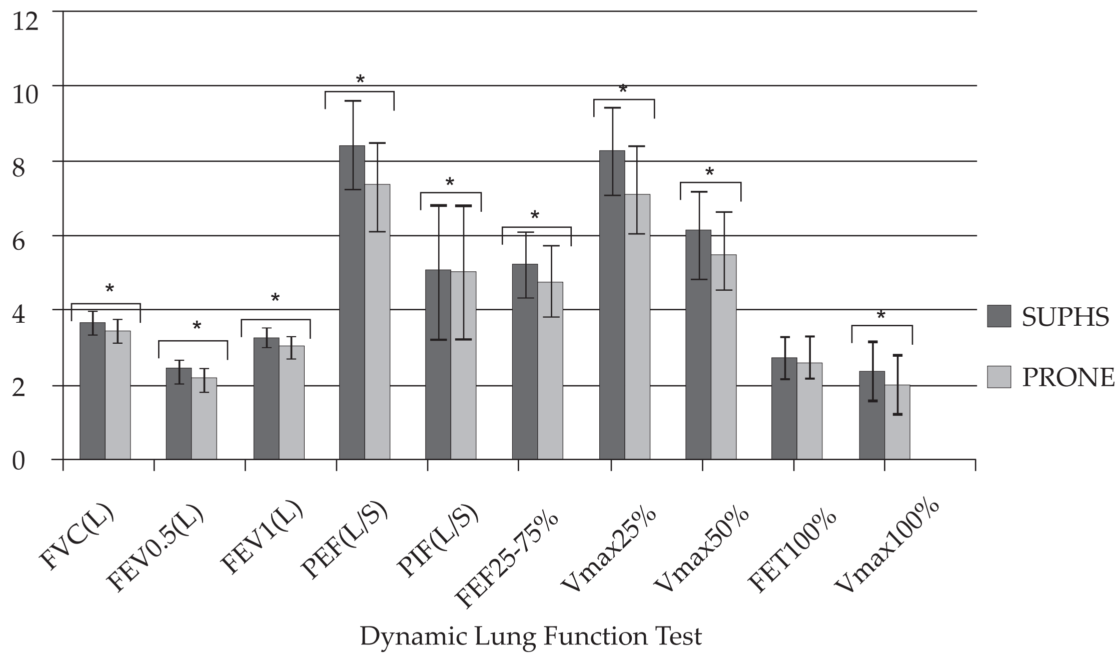


Fig 3: Showing comparison of dynamic lung function test between supine with head straight and prone posture.



References

1. Jan MA, Marshal I, Douglas NJ. Effect of posture on upper airway dimensions in normal human. Am J Respir Crit Care Med.1994; 149:145-148.
2. Ono T, Otsuka R, Kuroda T, Honda E, Sasaki T. Effects of head and body position on two- and three-dimensional configurations of the upper airway. J Dent Res 2000;79:1879-84.
3. Cart wright.R. Effects of sleep position on sleep apnea severity. Sleep.1984; 7:110-114.
4. AM Neill, SM Angus, D Sajkov, RD McEvoy. Effects of sleep posture on upper air way stability in patients with obstructive sleep apnea. Am.J.Respir.Crit.Care Med. 1997; 155(1):199-204.
5. Funakoshi.M, Amano.N. Effects of the tonic neck reflex on the jaw muscles of the rat. J.Dent.Res.1973; 52:668-663.
6. Liistro G, Stanescu D, Dooms G, Rodenstein D. Head position modifies upper airway resistance in men. J Appl Physiol.1988; 64:1285-1288.
7. Ryo Otsuka, Takashi Ono, Yasuo ishiwata, Takayuki kuroda. Respiratory-related Genioglossus EMG activity in response to head position and changes in body position. Angle Orthodontist. 2000; 70(1):63-69.
8. Downs J A, Stock.J. Effect of neck rotation on the timing and pattern of infant tidal breathing. Pediatr. Pulmonol.1995; 20:380-386.
9. Irene Szollosi, Teanau Roebuck, Bruce Thompson, Mathew T Naughton. Lateral sleeping position reduces severity of central sleep apnea/ cheyne stokes respiration. Sleep. 2006; 29(8):1041-1051.
10. B.K.Mahajan: Methods in Biostatistcs, 6th edition, Jaypee Brothers Medical Publishers (p) Ltd, New Delhi, India. pp. 35-130.
11. G.K.Pal. Reporting statistical information in a manuscript prepared for publication in a medical journal. Indian J Physiol Pharmacol. 2010; 54(1):1-4.
12. A Talwar, S Sood, J Sethi. Effect of body posture on dynamic lung functions in young non obese Indian subjects. Indian J Med Sciences. 2002; 56(12):607-612.

13. Pevernagrie DA, Stanson AW, Sheedy PF, Daniels BK, Shepard JW. Effects of body position on the upper airway of patients with obstructive sleep apnea. Am J Respir Crit Care Med. 1995; 152:179-185.

14. Elliot AR, Shea SA, Dijk DJ et al. Microgravity reduces sleep disordered breathing in humans. Am J Respir Crit Care Med.2001;164:478-485.

15. Hurewitz AN, Susskind H, Harold WH. Obesity alters regional ventilation in lateral decubitus position. J Appl Physiol 1985; 59:774-783.

16. Pump B, Talleruphuus V, Chouristensen NJ, Warberg J, Norsk P. Effects of supine, prone and lateral positions on cardiovascular and renal variables in humans. Am J Physiol Regul Integr Comp Physiol. 2002; 283:R174-180.

17. Melissions CG, Mead J. Maximum expiratory flow changes induced by longitudinal tension on trachea in normal subjects. J Appl Physiol respier Environ Exerc Physiol 1977;43:537-544.

18. Xia-ming shen, Da-Shu Huang, Feng gu Lin. Effect of positioning on pulmonary function of newborns: Comparision of supine and prone position. Pediatr. Pulmonol.1996; 21:167-170.

✦✦✦