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*Original Article*

# Polysomnographic findings in patients with sleep apnea syndrome in different body positions during sleep

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**Abstract.** There are some evidences that have approved the role of body position on various diseases and their causes. Respiratory diseases particularly disorders associated with respiratory rate and rhythm can be affected by the body position. Dizziness could be categorized as one of the most common medical complaints of patients referred to the neurology clinics. In this study, we aim to study polysomnographic findings in patients with sleep apnea syndrome in different positions during sleep. A cross-sectional study was conducted on 155 patients with sleep breathing disorders and Epworth sleepiness scale above 10 referred to the sleep clinic of Baqiyatallah Hospital during 2009–2011. After confirming the diagnosis of obstructive sleep apnea, polysomnography containing sleep breathing apnea-hypopnea indices (AHIs), different body positions, respiratory movements, oximetry pulse cases, EMG, EOG, and EEG were done by Alice device and the method was split night test. The mean age and BMI of patients were 50.62 ± 11.65 years old and 32.48 ± 7.19 respectively. There was a significant difference between AHI in supine position (25.78 ±21.01) versus lateral position; right (16.28 ± 22.40; $p<0.001$) or left (18.05 ± 21.04; $p=0.007$) but there was no significant difference between AHI in right versus left position ($p = 0.782$). According to the results of this study, it seems that apnea-hypopnea index in supine position could be worse than the left or right side sleeping position. However, this index value in each left and right lateral positions was not more than the other. In addition, desaturation value in supine position was significantly different from two others, but there were no preference in left or right positions.

**Keywords**: Polysomnography, sleep apnea syndrome, body positions, sleep

## Introduction

Sleep apnea syndrome is a type of clinical sleep disorder that is developing from recurrent apneas during sleep. Sleep apnea is categorized into three different types, namely, obstructive, central, and compound with total prevalence of 24% [1–4]. Polysomnography is recognized as a standard method of diagnosing sleep apnea. Polysomnographic definition of respiratory disorders during sleep is based on the abnormal respiratory events in every hour of the sleep that is called apnea-hypopnea Index (AHI). Usually up to five apnea-hypopnea events per hour is considered as being normal, but in children even one apnea event per hour is abnormal [3–5].

Different treatments including continuous positive airway pressure (CPAP), surgical procedures, using oral device, and changing the lifestyle are recommended for these patients. Some of the changing lifestyle that is approved for treatment of these patients include avoiding alcohol and muscle relaxants, losing excess body weight, stopping smoking habit, and elevating upper body 30 degree during the sleep [6]. Unlike supine position, lateral position is recommended for these patients [7, 8].

There is evidence that shows the effect of different body positions on sleep apnea solutions (SAS). It is shown in many patients that the obstructive sleep apnea (OSA) will exacerbate in supine position. According to the past studies, AHI is doubled in supine position than the lateral one [9, 10], and the intensity of apnea (apnea duration, minimal non saturate oxygen, arousal frequency, and duration) also increasing in the supine position [49]. Pressure to re-establish the flow of air is more in supine position [6]. Mechanism of exacerbation of sleep respiratory disorders in the supine position is not clear. Some studies considered the effectiveness of gravity on the shape and size of upper respiratory tract, but no consistent evidence reported the relationship between other body positions during sleep and SAS [12–14]. In addition, there are recommendations for sleeping positions in Islamic sources that can be considered as advises to improve sleep of these patients. Although there are studies aimed at investigating the probable relationship between sleeping positions and polysomnographic indices, supplementary

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TABLE 1
APNEA-HYPOPNEA (AHI) AND DESATURATION IN TERMS OF SLEEP POSITIONS*

| Variable | Position | No | Mean | SD | 95%CI | |
|---|---|---|---|---|---|---|
| | | | | | Lower bound | Upper bound |
| Total AHI | Supine | 154 | 25.7844 | 21.01862 | 22.4383 | 29.1305 |
| | Left | 138 | 18.0507 | 21.40091 | 14.4483 | 21.6531 |
| | Right | 130 | 16.2885 | 22.40715 | 12.4002 | 20.1767 |
| | Total | 422 | 20.3301 | 21.93322 | 18.2314 | 22.4288 |
| Desaturation | Supine | 154 | 1.28E+02 | 146.4503 | 104.2764 | 150.9054 |
| | Left | 138 | 42.6014 | 66.09654 | 31.4754 | 53.7275 |
| | Right | 130 | 34.7077 | 62.18183 | 23.9174 | 45.498 |
| | Total | 422 | 71.1848 | 110.6502 | 60.5973 | 81.7724 |

* CI: confidence interval, SD: standard deviation.

work need to be carried out on this (15). In this study, we wanted to study polysomnographic findings in patients with sleep apnea syndrome in different positions during sleep.

## Materials and Methods

A cross-sectional study was done on the patients with sleep breathing disorders referred to sleep clinic of Baqiyatallah Hospital and has been under the polysomnography during 2009–2011. After clinical examinations of patients complaining of sleep disorders and approval of indication of PSG through Epworth Sleepiness Scale (ESS) tests (usually with a score above 10) by physician, they were nominated for doing polysomnography.

After visiting the sleep lab, the polysomnography started from 6 p.m. to 6 a.m. and their different sleep parameters including sleep breathing AHI, different body positions, respiratory movements, oximetry pulse cases, electromyogram (EMG), electrooculogram (EOG), and electroencephalogram (EEG) during sleep were recorded. Tests were done by Alice device and the method was Split Night Test. The final number of patients was 155. The informed consents were obtained from all patients and the study was approved by the Institutional Review Board of Baqiyatallah University of Medical Sciences, Tehran, Iran.

## Statistical analysis

Data collected were entered and analyzed using the SPSS software version 16 (SPSS Inc., Chicago, IL). Tables and charts were extracted. Descriptive statistics were calculated for quantitative data and the qualitative variables were expressed as counts and percentage. The relationship between qualitative variables was examined through chi squared statistical test, whereas the quantitative variables used *t*-test and analysis of variance (ANOVA). Also, some nonparametric tests such as Wilcoxon test, Mann–Whitney U test, and Friedman test were used. Data are presented as Mean ± SD.

## Results

The mean age of the patients was 50.62 ± 11.65 years, body mass index (BMI) was 32.48 ± 7.19, neck circumference was 41.41 ± 3.64 cm, the waist circumference was 111.51 ± 17.07 cm, total sleep time (TST) was 465.6 ±72.93 h, sleep efficacy 1 was 86.64 ± 10.65, sleep efficacy 2 was 89.43 ± 9.86, sleep efficacy 3 was 29.64 ± 12.02, average sleep duration at supine was 297.47 ± 139.20 min, sleep duration at left side was 127.98 ± 86.56 min, sleep duration at right side was 120.38 ± 89.44 min, AHI in supine was 25.78 ±21.01, AHI in left was 18.05 ± 21.04, AHI in right was 16.28 ± 22.40, desaturation in supine was 127 ± 146.45, desaturation in left position was 42.5 ± 66.09, desaturation in right position was 34.70 ± 62.1. Mean desaturation and the SD were 92.58 and 3.15, respectively. The minimal amount of desaturation was 76.79 with SD of 15.40. Among all of the patients, 109 (70.3%) were men and 46 (29.7%) were women. The mean age among women and men were 56.63 ± 12.79 and 48.0 ± 10.18 years, respectively (Table 1).

There was a significant difference between the age ($p < 0.001$, $r = -4.4.08$, confidence interval (Cl): 95%: 12.36–4.71), BMI ($p < 0.001$, $r = -3.756$), neck circumference ($p = 0.003$, $r = 2.98$), waist circumference ($p = 0.076$, $r = -1.78$), and TST ($p = 0.811$, $r = 0.239$). The results in the examination of AHI in terms of sleep positions (supine, right, and left) are reported in the following section. There was a significant difference in amount of AHI in different positions with $p < 0.001$. AHI in supine position was significantly different from left lateral one ($p = 0.007$). Also, the amount of AHI in supine was clearly different from right lateral position ($p = 0.001$) as well as difference of desaturation in left, right, and supine positions (Table 2). But there were no significant differences in AHI between right and left lateral positions ($p = 0.782$). There was a significant difference between desaturation in right, left, and supine positions but not between right and left lateral positions alone ($p < 0.001$). In this case, there was a statistically significant association between desaturation

TABLE 2
PROBABILITY (P) VALUES OF APNEA INDEX AND DESATURATION IN TERMS OF SLEEP POSITIONS

| Variable | Position | Direction | P value |
|---|---|---|---|
| Total AHI | Supine | Left | 0.007 |
| | | Right | 0.001 |
| | Left | Supine | 0.007 |
| | | Right | 0.782 |
| | Right | Supine | 0.001 |
| | | Left | 0.782 |
| Desaturation | Supine | Left | 0.00 |
| | | Right | 0.00 |
| | Left | Supine | 0.00 |
| | | Right | 0.803 |
| | Rright | Ssupine | 0.00 |
| | | Left | 0.803 |

and AHI values in supine positions ($p < 0.001$, $r = 0.602$). There was no significant association between AHI values in supine position and sleep efficacy ($p = 0.291$). Also, there was no significant association between desaturation values in supine position and sleep efficacy 3 ($p < 0.422$).

There was a significant association between AHI values and desaturation in left lateral position ($p < 0.001$, $r = 0.781$), but not between them and sleep efficacy 3 ($p = 0.646$). However, there is no significant association between desaturation in left position and sleep efficacy ($p = 0.407$). Also, there was a significant association between AHI and desaturation values in right lateral position ($p < 0.001$, $r = 0.784$), and these values were not associated with sleep efficacy 3 ($p = 0.729$). Also, there was no significant association between desaturation in right lateral position and sleep efficacy ($p = 0.681$).

There was no significant association between BMI and sleep efficacy 3 values ($p = 0.868$). Although there was no significant association between BMI and right AHI ($p < 0.001$, $r = 0.373$) and also desaturation in right lateral, ($p < 0.001$, $r = 0.510$) there was a significant association between BMI values and AHI in left lateral position ($p < 0.001$, $r = 0.367$), AHIS ($p = 0.002$, $r = 0.245$), desatura-tion in left lateral position ($p < 0.001$, $r = 0.507$), and desaturation in supine position ($r = 0.403$ and $p < 0.001$). Also, there was a significant association between age and the amount of desaturation in right position ($p = 0.008$, $r = 0.233$), but not between age and amounts of AHIS ($p = 0.231$), AHIL ($p = 0.067$), AHIR ($p = 0.186$), desaturation in supine ($p = 0.260$), and left ($p = 0.187$) positions.

The linear regression showed that the only predictors of AHI values were neck circumference ($p = 0.004$, $r = 2.923$) and desaturation in supine position ($p < 0.001$, $r = 8.216$). About this index in the left position, age ($p = 0.041$, $r = 2.066$) and desaturation ($p < 0.001$, $r = 8.145$) in left and about the index in the right position, BMI ($r = 2.562$, $p = 0.012$), neck circumference ($p = 0.006$, $r = 2.779$), waist circumference ($p = 0.005$, $r = 2.843$), and desaturation ($p < 0.00$, $r = 4.513$) in right were predictors.

**Discussion**

According to the results of this study, it seems that AHI in supine situation could be worse than the left or right side sleeping position. However, this index values in each left and right lateral positions was not more than the other. In addition, desaturation value in supine position was significantly different from two others, but there were no preference in left or right positions. BMI was significantly associated with AHI value in the right situation and the right desaturation. Neck and waist circumference and desaturation in left and right were associated with AHI, and also, there was an association between age and right desaturation. In multivariate analysis, it seems that AHI in supine position is associated with neck circumference and desaturation in this position and also as the left AHI with age and left desaturation and right AHI with BMI, neck and waist circumference, and desaturation.

In a paper published in 2012 by Bahammam [16] reviewing stories, verses, and Islamic traditions, he tried to make medical recommendations about situation and direction of sleep. In this paper, the right side has been particularly emphasized in early sleep, but there is no emphasis on the possible effects of it. In addition, it has been found that sleeping in supine, right, and left lateral decubitus positions could be effective on the health of heart that is nearly compatible with low AHI value that could have effects such as arrhythmia on heart health. However, past studies showed that sleeping in right lateral decubitus can effect on vague nerve, and so, it inhibits the arrhythmia and improves cardiac function in patients with CHF that is not comparable with current study, because this study does not examine the effects on autonomic nervous system. But generally, it can be reasonable according to the lowest amount of right desaturation among different sleeping positions; however, the effects of desaturation on making arrhythmia and probably disorders of nervous system of the heart [16].

In a study on 131 patients with OSA by Ozeke in 2011 [15], right-sided sleeping position (RSSP) compared to left-sided sleeping position (LSSP) and supine position provided greater reduction in frequency of apnea-hypopnea events in patients with moderate or severe OSA, and this is compatible with our study. In that study, the average AHI in supine, LSSP, and RSSP were $60.4 \pm 36.2$, $30.2 \pm 32.6$, and $23.6 \pm 30.1$ h, respectively. But there was no difference between LSSP and RSSP in patients with mild apnea ($p = 0.130$), and again these results and values in different positions are consistent with our study [15].

In another study on 16 patients with mild to moderate OSA by Lee in 2009 in Korea [17], the influence of lateral position with cervical support by head tilting and scapula support in reduction of AHI have been reported that has not been discussed in this study, but this support can be examined in different sleeping positions in future studies.

A study by Fan Maanen in 2011 [18] on 30 patients examined the function of an intelligent neck brace on a

patient with OSA during the sleep. This device was shaking in supine position, so the patient would change his/her status. In that study, the patient's AHI have been reduced from 27.7 ± 2.4 to 12.8 ± 2.2 h without any reduction in sleep duration and the AHI became less than 5 in 7 patients [18]. Therefore, he concluded that the supine position increases the apnea that can be justified by relaxation of muscles in the upper respiratory tracts and it is compatible with our results.

Different mechanisms have been suggested for AHI reduction in right lateral decubitus in patients with sleep apnea including the influence on reduction of unwanted flow by Patient Foramen Oval (PFO) that is very common in these patients. However, sleeping in the right side can decrease the liver weight on the input of blood to the heart, right to left shunt, and pulmonary blood pressure by increasing the Valsalva maneuver and vagus system stimulation, so the desaturation will be decreased. In addition, sleeping in right lateral decubitus can be associated with reduction in pressure of central airways that would accompany with smaller amounts of OSA [19].

Also, the right lung volume is greater than the left that can provide more oxygenation. Sleeping in right lateral decubitus increase blood flow to right lung more than the left one and therefore the amounts of oxygenation increase. The contents related to cardiac findings in patients with OSA and the effect of position on it have been mentioned just for discussion and explanation of possible causes. Supplementary studies focusing on results of cardiac tests are required to definitely prove the subject and the relationship between above items.

In conclusion, according to the results of our study, it is better for patients with sleep apnea to sleep in the right and left lateral decubitus, although there is no difference between right and left positions. In addition, due to the association of higher rates of apnea, hypopnea and desaturation with overweight and the resulted high apple-shaped waist circumference and high neck circumference, so it seems logical to advise these patients to lose weight. It is suggested to examine sleep disorders by comparing AHI, desaturation, sleep effectiveness, and so on between sleep disorders and other physical disorders.

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**Conflict of interest**

The authors declare no conflicts of interest and no financial support.

**References**

1. Young T, Peppard PE, Gottlieb DJ. Epidemiology of obstructive sleep apnea: A population health perspective. Am J Respir Crit Care Med 165:1217-1239, 2002.

2. Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep-disordered breathing among middle-aged adults. N Engl J Med 328:1230-1235, 1993.

3. Bearpark H, Elliott L, Grunstein R, Cullen S, Schneider H, Althaus W, Sullivan C. Snoring and sleep apnea: a population study in Australian men. Am J Respir Crit Care Med 151:1459-1465, 1995.

4. Punjabi NM. The epidemiology of adult obstructive sleep apnea. Proc Am Thorac Soc 5:136-143, 2008.

5. Rombaux P, Bertrand B, Boudewyns A, Deron P. Standard ENT clinical evaluation of the sleep-disordered breathing patient: A consensus report. Acta Otorhinolaryngol Bleg 56:127-137, 2002.

6. Neill AM, Angus SM, Sajkov D, McEvoy RD. Effects of sleep posture on upper airway stability in patients with obstructive sleep apnea. Am J Respir Crit Care Med 155:199-204, 1997.

7. Loord H, Hultcrantz E. Positioner- a method for preventing sleep apnea. Acta Otolaryngol 127: 861-868, 2007.

8. Szollosi I, Roebuck T, Thompson B, Naughton MT. Lateral sleeping position reduces severity of central sleep apnea/Cheyne-stokes respiration". Sleep 29:1045-1051, 2006.

9. Cartwright RD. Effect of sleep position on sleep apnea severity. Sleep 7:110-114, 1984.

10. Oksenberg A. Positional vs nonpositional obstructive sleep apnea patients: anthropomorphic, nocturnal polysomnographic, and multiple sleep latency test data. Chest 112:629-639, 1997.

11. Oksenberg A. Association of body position with severity of apneic events in patients with severe nonpositional obstructive sleep apnea. Chest 118:1018-1024, 2000.

12. Isono S. Lateral position decreases collapsibility of the passive pharynx in patients with obstructive sleep apnea. Anesthesiol 97:780-785, 2002.

13. Fouke JM. Effect of position and lung volume on upper airway geometry. J Appl Physiol 63:375-380, 1987.

14. Kairaitis K. Tracheal traction effects on upper airway patency in rabbits: the role of tissue pressure. Sleep 30:179-186, 2007.

15. Ozeke O, Erturk O, Gungor M, Hızel SB, Aydın D, Celenk MK, Dıncer H, Ilıcın G, Ozgen F, Ozer C. Influence of the right- versus left-sided sleeping position on the apnea-hypopnea index in patients with sleep apnea. Sleep Breath 16:617-620, 2011.

16. Bahammam AS. Sleep from an Islamic perspective. Ann Thorac Med 6:187-192, 2011.

17. Lee JB, Park YH, Hong JH, Lee SH, Jung KH, Kim JH, Yi H, Shin C. Determining optimal sleep position in patients with positional sleep-disordered breathing using response surface analysis. J Sleep Res 18:26-35, 2009.

18. Van Maanen JP, Richard W, Van Kesteren ER, Ravesloot MJ, Laman DM, Hilgevoord AA, DE Vries N. Evaluation of a new simple treatment for positional sleep apnea patients. J Sleep Res 21:322-329, 2011.

19. Fujita K, Wada Y, Aono T et al. Sleep apnea syndrome in patients with cardiac disease. Rinsho Byori 56:767-771, 2008.