Positional Therapy: Left Lateral Decubitus Position Versus Right Lateral Decubitus Position

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Introduction

Visceral organs in the thoracic cavity, i.e., the right and left lungs, the heart, the esophagus, and the trachea, are not symmetrically distributed in the thorax. It has been reported that right-side sleepers had better sleep quality and less nightmares compared to left-side sleepers [1]. Furthermore, patients with congestive heart failure avoid the left lateral decubitus position spontaneously during sleep [2]. In congestive heart failure patients, sympathetic nervous modulation was most attenuated in the right lateral decubitus sleep position [3, 4].

Obstructive sleep apnea (OSA) is associated with increased cardiovascular and cerebrovascular morbidity and mortality rates [5–7]. Sleeping position has a major influence on sleep-related breathing disorders [8, 9]. The deleterious effect of the supine posture and the helpful effect of the lateral position on sleep-related breathing abnormalities have been reported consistently [10–12]. Ozeke et al. [13, 14] found that right lateral decubitus sleep position decreased the frequency of obstructive respiratory events in patients with moderate and severe disease. They speculate that the presence of underlying OSA, which is frequently encountered in

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patients with heart failure, may be one of the mechanisms explaining the demonstrated preference of patients with heart failure for the right lateral decubitus sleep position. However, evidence for whether or not the numbers of respiratory events are different between left and right lateral decubitus position is lacking. The purpose of the present study was to observe the effects of supine and left and right lateral decubitus positions on the rapid eye movement (REM) sleep, apnea-hypopnea index (AHI), and minimum arterial oxygen saturation (SaO_2) in adult OSA patients.

Materials and Methods

We retrospectively reviewed all subjects with suspected OSA who underwent consecutive overnight diagnostic polysomnographies (PSGs) between June 2009 and June 2012 in the Sleep Center of the Affiliated Eye, Ear, Nose, and Throat Hospital of Fudan University, Shanghai, China. Sleep data were scored manually and automatically according to standard criteria [15]. Body position was monitored continuously by a body position sensor, which was taped onto the skin overlying the sternum. After calibration, the patient was instructed to rotate in the bed to confirm that every position would be recorded correctly.

Adult subjects age ≥ 18 with an AHI ≥ 5 were included in the study. To control for intrasubject differences caused by sleep architecture, only subjects who spent more than 20 % of total sleep time in supine and left and right positions were included for further analysis.

Left positional OSA was defined as a total AHI ≥ 5 with a supine AHI that is at least two times higher than their left AHI, and right positional OSA was defined as a total AHI ≥ 5 with a supine AHI that is at least two times higher than their right AHI. To further study the theoretical efficacy of postural intervention in OSA patients, subgroup analysis of the following parameters was performed: sex, age, BMI, and the severity of OSA. Subjects were divided on the basis of their age into three groups (18–39 years, 40–59 years, and above 60 years). BMI was divided into three categories: normal body weight (18.5–23.9 kg/m^2), overweight (24.0–27.9 kg/m^2), and obesity ($\geq$28 kg/m^2). According to Bei-Fan et al. [16], AHI was defined by the standard criteria [17]. The severity of sleep apnea was classified using the total AHI: mild sleep apnea was defined as a total AHI of 5–14.9 per hour, moderate sleep apnea as a total AHI of 15–29.9 per hour, and severe sleep apnea as a total AHI ≥ 30 per hour.

All results were expressed as mean $\pm$ standard deviation. SPSS (Statistical Package for Social Sciences) 17.0 program for Windows was used for statistical analysis of the results in our study. T-test and ANOVA were used to compare continuous results. Statistical significance was set at $P < 0.05$.

Results

Influence of Body Posture on Percentage of REM Sleep, AHI, and Minimum SaO_2

Out of a total of 2,221 studied subjects, 327 cases were included for further analysis. A male preponderance was found (314 patients or 96.0 %). The age distribution is shown in Fig. 1. 45 (13.8 %) cases suffered from mild, 70 (21.4 %) from moderate, and 212 (64.8 %) from severe OSA (Fig. 2).

The percentages of total sleep time spent in supine and left and right lateral decubitus positions showed no differences (33.5 % ± 6.7 %, 32.8 % ± 8.2 %, and 33.2 % ± 8.6 %, respectively; $P = 0.483$, Table 1). No significant difference could be found in the percentages of REM sleep in supine and left and right lateral decubitus positions (6.1 % ± 4.2 %, 6.5 % ± 4.2 %, and 6.4 % ± 4.2 %, respectively; $P = 0.424$, Table 1). Supine AHI was 60.5 ± 24.3 per hour, which was higher compared to 36.4 ± 28.4 per hour in the left lateral decubitus position ($P < 0.001$) and 35.3 ± 28.1 per hour in the right lateral decubitus position ($P < 0.001$, Table 1 and Fig. 3). In the supine position, the minimum SaO_2 was 76.5 % ± 10.8 %, which was lower compared to 80.0 % ± 10.2 % in the left lateral decubitus position ($P < 0.001$) and 80.0 % ± 10.1 % in the right lateral decubitus position ($P < 0.001$, Table 1 and Fig. 4). No significant difference could be found between left and right AHI ($P = 0.607$), and between left and right minimum SaO_2 ($P = 0.798$).

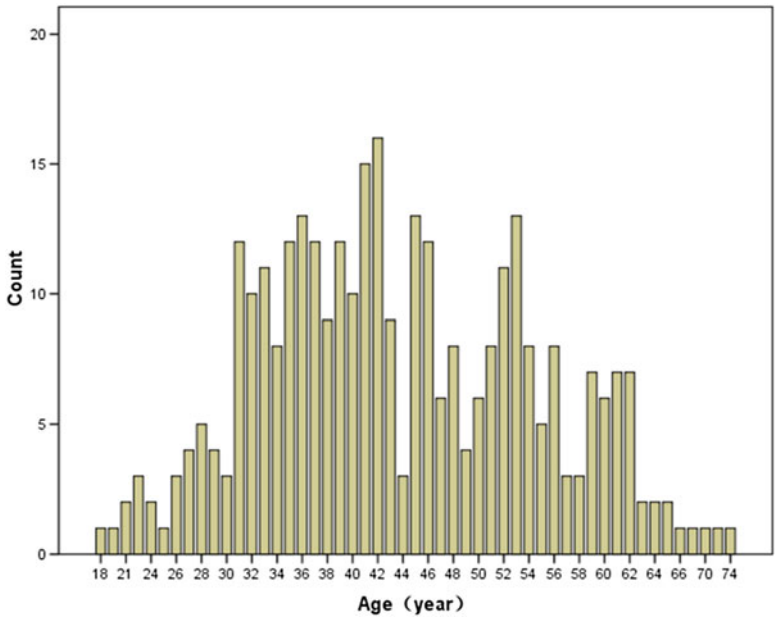

Fig. 1 Age distribution of 327 patients

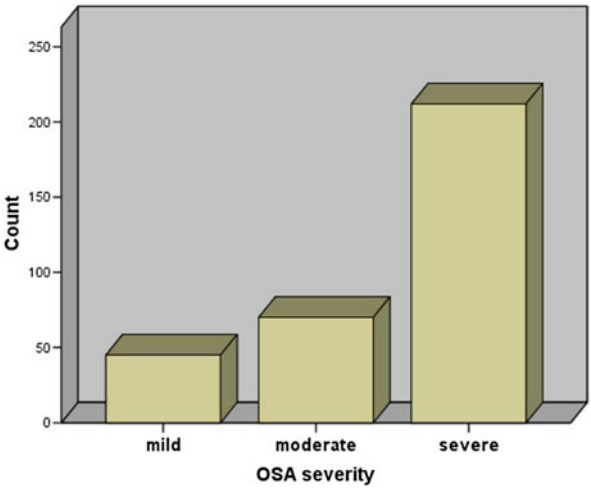

Fig. 2 Distribution of OSA severity: 45 (13.8 %) cases were mild OSA, 70 (21.4 %) cases were moderate OSA, and 212 (64.8 %) cases were severe OSA

Table 1 Comparison of supine and left and right lateral decubitus positions

	Supine	Left lateral decubitus	Right lateral decubitus	*P*-value
Sleep time (% TST)	33.5 ± 6.7	32.8 ± 8.2	33.2 ± 8.6	0.483
REM (% TST)	6.1 ± 4.2	6.5 ± 4.2	6.4 ± 4.2	0.424
AHI (per hour)	60.5 ± 24.3	36.4 ± 28.4	35.3 ± 28.1	<0.001
Min SaO_2 (%)	76.5 ± 10.8	80.0 ± 10.2	80.0 ± 10.1	<0.001

Values are given as mean ± SD

REM rapid eye movement, *TST* total sleep time, *AHI* apnea-hypopnea index, *Min* SaO_2 minimum arterial oxygen saturation

Factors Influencing the Prevalence of Left and Right Positional OSA: Effect of Gender, Age, BMI, and OSA Severity

Based on the definition of left and right positional OSA mentioned earlier, out of 327 OSA patients, left positional sleep apnea was seen in 155 (47.4 %) patients, and right positional sleep apnea was seen in 161 (49.2 %) patients. The prevalence of left and right positional OSA showed no difference ($P = 0.639$). Subgroup analysis using gender, age, BMI, and OSA severity showed no statistically significant difference between the prevalence of left and right positional OSA (Table 2). Prevalence of left and right positional OSA was not affected by gender or age. However, as BMI and AHI increased, prevalence of left and right positional OSA decreased (Table 2).

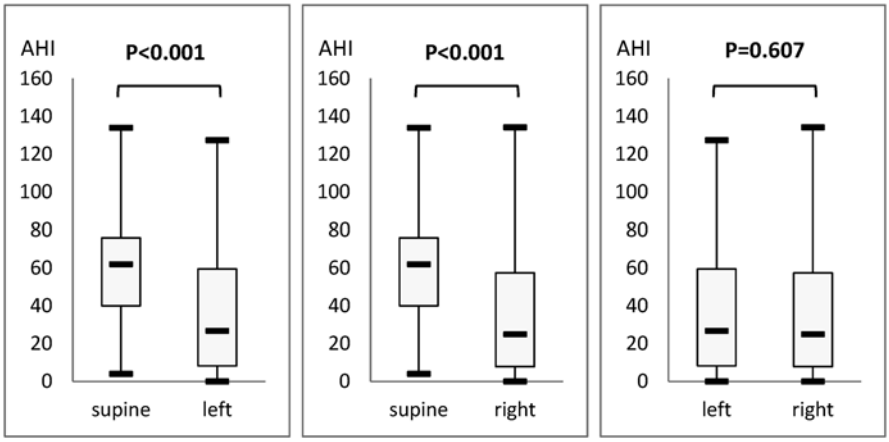

Fig. 3 Supine AHI was 60.5 ± 24.3 per hour, which was higher compared to 36.4 ± 28.4 per hour in left position ($P < 0.001$) and 35.3 ± 28.1 per hour in right position ($P < 0.001$). No statistically significant differences could be found between left and right AHI ($P = 0.607$)

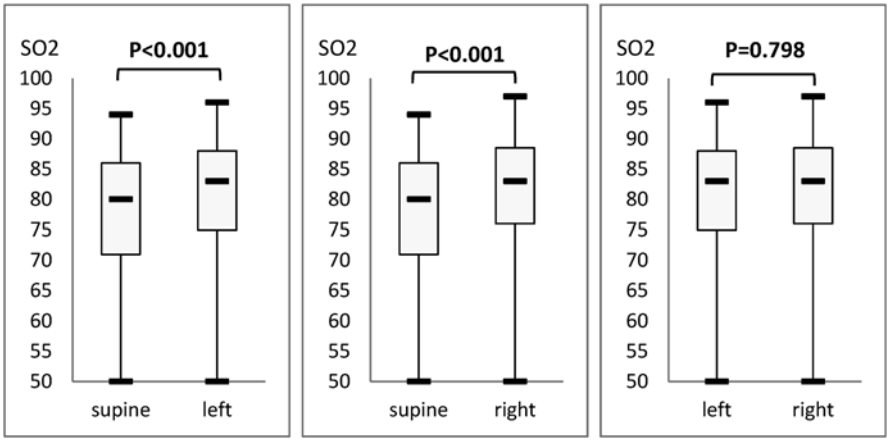

Fig. 4 Minimum SaO_2 in supine position was 76.5 ± 10.8 %, which was lower compared to 80.0 ± 10.2 % in left position ($P < 0.001$) and 80.0 ± 10.1 % in right position ($P < 0.001$). No statistically significant differences could be found between left and right minimum SaO_2 ($P = 0.798$)

Table 2 Factors influencing the prevalence of left and right positional OSA: effect of gender, age, BMI, and OSA severity

Factors	No.	Supine AHI/left AHI > 2	Supine AHI/right AHI > 2	*P*-value
Total	327	155 (47.4 %)	161 (49.2 %)	0.639
Gender				
Male	314	148 (47.1 %)	155 (49.4 %)	0.576
Female	13	7 (53.8 %)	6 (46.2 %)	0.695
P-value		0.635	0.821	
Age (years)				
18–39	128	65 (50.8 %)	67 (52.3 %)	0.802
40–59	168	77 (45.8 %)	81 (48. 2 %)	0.662
≥60	31	13 (41.9 %)	13 (41.9 %)	1.000
P-value		0.570	0.542	
BMI (kg/m^2)				
Normal	49	30 (61.2 %)*	30 (61.2 %)*	1.000
Overweight	161	85 (52.8 %)*	88 (54.7 %)*	0.737
Obesity	117	40 (34.2 %)	43 (36.8 %)	0.682
P-value		0.001	0.002	
Total AHI (per hour)				
Mild	45	37 (82.2 %)**	35 (77.8 %)**	0.598
Moderate	70	56 (80.0 %)**	60 (85.7 %)**	0.370
Severe	212	62 (29.2 %)	66 (31.1 %)	0.672
P-value		<0.001	<0.001	

Left positional sleep apnea was defined as a total AHI ≥ 5 with a supine AHI that is at least two times higher than their left AHI, and right positional sleep apnea was defined as a total AHI ≥ 5 with a supine AHI that is at least two times higher than their right AHI

AHI apnea-hypopnea index, *BMI* body mass index

*$P < 0.05$ vs. obesity subjects

**$P < 0.001$ vs. severe OSA subjects

Discussion

In this study, left and right lateral decubitus positions were compared with regard to their influence on the percentage of REM sleep, AHI, and minimum SaO_2. As we currently know, sleeping state influences many aspects of respiration. People in REM sleep are most vulnerable for having sleep-disordered breathing, and many OSA patients have higher AHI and lower SaO_2 in REM sleep than in non-REM sleep [18, 19]. To eliminate interindividual differences caused by sleep architecture, subjects should spend enough time in the supine and left and right lateral decubitus positions during PSG examinations. To provide this validity, adult OSA patients who spent more than 20 % of total sleep time in each of the three study sleeping positions were enrolled in the analysis. This inclusion criterion was so strict that, among 2,221 subjects, only 327 patients met the eligibility criteria. This is a population with a lot of severe OSA (212 in 327) and male (314 in 327) patients.

A staggering percentage of severe OSA patients and male preponderance are not uncommon in the sleep centers of China. A multicenter investigation in China showed that, among 2,297 consecutive patients (aged 18–85 years; 1,981 males and 316 females), 257 patients had AHI ≤ 5, 402 patients had AHI > 5 and ≤15, 460 patients had AHI > 15 and ≤30, and 1,178 patients had AHI > 30 [20]. This is due to poor-quality health care and lack of health consciousness in China. A large quantity of Chinese patients won't go to hospital and take PSGs unless their OSA complaints are serious.

Using the inclusion criteria, subjects spent an almost equal percentage of sleep time in supine and left and right lateral decubitus positions ($P = 0.483$). Percentages of REM sleep time in supine and left and right lateral decubitus positions showed no significant difference ($P = 0.424$), although AHI was higher and minimum SaO_2 was lower in the supine position (Table 1). This could mean that percentage of REM sleep time is associated with sleep time and is unaffected by sleep position, AHI, and minimum SaO_2 in OSA patients. Nakano et al. [21] showed that percentage of REM sleep time in a non-apneic snorer group (AHI < 15) and an apneic group (AHI > 15) showed no differences (14.6 % ± 7.9 % of TST vs. 14.0 % ± 5.6 % of TST, $P > 0.05$), indicating that percent of REM sleep time is unaffected by AHI. However, Nakano et al. [21] also reported that apneic patients tended to have more REM sleep in the lateral than in the supine position. This means that percentage of REM sleep time was affected by sleep position in apneic patients and is not in line with our present findings. A possible explanation for this discrepancy is that Nakano et al. didn't balance the lateral time and supine time during PSG examination when analyzing REM sleep time in lateral and supine position.

OSA patients have higher AHI scores in supine position which are often associated with the greatest decrease in SaO_2 [18]. Studying AHI and minimum SaO_2, the theoretical interventional efficacy of left and right lateral decubitus positions showed no statistically significant differences. These results differ from Ozeke et al. [13], who reported that the left lateral decubitus positional AHI score was significantly higher than that of right lateral decubitus position (30.2 ± 32.6 per hour vs. 23.6 ± 30.1 per hour; $P < 0.001$). We don't know if this difference is related to ethnical differences. We assume that the upper airway structure is symmetrical. When the lower jaw and soft palate move downward from gravitational forces, the width of the upper airway must be the same in left and right lateral decubitus positions. Furthermore, our study is based on a much larger sample than Ozeke et al. Therefore, our results may lead to more reliable statistical inferences.

When positional OSA was defined as a supine AHI that is at least two times higher than their non-supine AHI, the percentage of positional OSA patients varies in different reports from 9 % to 60 % [9, 22–24]. This variation is probably due to the different types of OSA patients studied. In our study, left positional sleep apnea was seen in 47.4 % patients, and right positional sleep apnea was seen in 49.2 % patients.

In subgroup analysis, we found that both left and right positional OSA are common in nonobese and non-severe OSA patients. This was similar to findings in other studies that showed positional OSA patients to be thinner and have less severe OSA than non-positional patients [9].

For some patients, when the percentage of supine time would be reduced to 0 (and the AHI in the supine position would not be of influence any longer), the AHI values of left and right lateral decubitus positions are ≥30. This indicates that if this group of patients would be prescribed some kind of ideal positional therapy, their lowest possible AHI after treatment still is ≥30. So the clinical consequence of positional therapy for this group of patients could be of limited value. However, as a free, and in the future possibly convenient, treatment for OSA, positional therapy (e.g., using the tennis ball technique) is available to patients who can't afford other treatments (e.g., surgery, continuous positive airway pressure, oral appliances, etc.). This is especially true for patients in developing countries.

Conclusion

Percentage of REM sleep seems to be unaffected by sleep position in OSA patients. Left and right lateral decubitus positions had a same influence on AHI and minimum SaO_2. The prevalence of left and right positional OSA is similar. Positional therapy could be an effective treatment for OSA, especially for the nonobese and non-severe OSA patients.

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