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The role of sleep position in obstructive sleep apnea syndrome

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Abstract We analyzed the role of sleep position in obstructive sleep apnea syndrome (OSAS). The polysomnograms of 120 patients with sleep apnea syndrome were analyzed. We associated the apnea hypopnea index (AHI) of the supine position with the AHI of the other positions. Patients were stratified in a group of positional patients (PP) (AHI supine ≥ 2 × AHI other positions) and a group of non-positional patients (NPP). In 55.8% of our patients, OSAS was position dependent. PP patients were significantly (6.7 years) younger. BMI and AHI were higher in the NPP group, but the difference was not significant. Level of obstruction in the upper airway (retropalatinal vs retrolingual vs both levels) as assessed by sleep endoscopy was not significantly different between the two groups. Total sleep time (TST) was equal in both groups, but the average time in supine position was 37 min longer in the PP group. This study confirms the finding that in more than 50% of patients, OSAS is position dependent. Apart from age, no patient characteristics were found indicating the position dependency. Overall AHI does not identify positional OSAS.

Keywords Body position · Obstructive sleep apnea syndrome

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Introduction

Obstructive sleep apnea syndrome (OSAS) is a common clinical problem [1]. The prevalence of OSAS in middle-aged people (30–60 years) is 2% in women and 4% in men [2]. In practice obstructive sleep apnea seems to be under-reported; roughly 85% of patients with obstructive sleep apnea are undiagnosed [3]. Due to longer life-expectancy and increase in weight in the general population, its incidence can be expected to rise.

OSAS is characterized by periods of cessation and reduction of the oronasal airflow during sleep accompanied by desaturations of blood oxygen. This sleep related breathing disorder is a result of abnormal anatomy (crowding of the upper airway) superimposed on normal sleep physiology (reduction of muscle tone).

Clinical symptoms are (in descending order of frequency) snoring, unquiet sleep, daytime fatigue, diminished intellectual ability and changes in personality. If OSAS remains untreated, patients are at higher risk to develop cardiovascular diseases [4–9]. In case of AHI > 40 the risk to be involved in a traffic accident increases [10].

Treatment of OSAS consists of lifestyle alterations such as weight reduction and reducing alcohol, sedatives and sleep medication. Conservative interventions include mandibular repositioning advancements in mild to moderate OSAS, and nasal continuous positive airway pressure (NCPAP) in severe OSAS [11, 12]. NCPAP acts as a pneumatic splint, which dilates the airway and prevents its collapse during sleep. However, up to 50% of patients are not willing to start or to comply to NCPAP therapy [13, 14]. Also, a variety of surgical modalities is frequently applied.

Although many patients snore louder and have more apneas in supine position only a limited number of studies have been reported on the role of sleep position [15–21] and, subsequently, interventions to decrease the severity of OSAS by influencing sleep position [22]. In this paper we present our analysis of the role of sleep position in OSAS.

Methods

We analyzed the overnight polysomnograms of all patients who visited our department from March 2003 to January 2005 because of habitual snoring and/or suspicion of OSAS. Polysomnography was recorded using a digital polygraph system (Embla, Flaga Medical Devices, Reykjavik, Iceland). Electroencephalogram (Fp2-C4/Fp1-C3), electrooculogram and submental electromyogram were used to record the sleep pattern. Nasal airflow was measured by a pressure sensor. Thoracoabdominal excursions were registrated by straps containing piezoelectric transducers. Pulse oximetry was used to monitor oxygen saturation (SaO_2) and heart rate. In addition ECG, movements of the limbs and the intensity of snoring were recorded.

Body position was determined by a position sensor (Pro-Tech, Woodinville, WA, USA), which was attached to the midline of the abdominal wall. This sensor differentiated between the upright, left side, right side, prone and supine position. All signals were recorded with digital sampling, digital filtering, digital storage (DDD) recording technology, permitting a sample efficiency of 90% and a sample rate up to 200 Hz. Storage was done on a PCMCIA flash-card. We considered unknown position as non-supine, because the sensor only gives unclear registration (fluttering) when patients turn to other positions or when patients sleep in intermediate position (half on the back and half on the side).

Patients who met the criteria for OSAS and in whom surgical therapy was considered, underwent sleep endoscopy under midazolam or propofol sedation to investigate the level of obstruction of the upper airway and soft tissue collapse [23, 24].

The recommended diagnostic criteria for OSAS include an apnea hypopnea index (AHI) of five or more and evidence of daytime sleepiness [25]. The AHI is the mean number of apneas and hypopneas per hour during sleep. An apnea is a period of 10 s without oronasal airflow. A hypopnea is an episode of more than 30% airflow reduction of the baseline (calculated from the preceding period of 100 s) during at least 10 s. Suggested AHI thresholds are 5, 15 and 30 events per hour for mild, moderate and severe levels of OSAS, respectively [25]. We defined position dependent OSAS as an at least two times higher AHI in supine position than the average AHI in the other positions. To score the severity of daytime sleepiness, we used the Epworth Sleepiness Scale (ESS) [26]. Patients who had an AHI between five and ten had to have at least an ESS score of seven to be included in this study.

Statistical methods

All measurements of all patients were used. Differences between the PP and the NPP group were calculated by means of the Wilcoxon two-sample test for continuous variables and with the Fisher's exact test or the Cochran–Armitage trend test for ordered categories. To calculate the difference between the AHI in REM sleep and the AHI in NREM sleep we used the Signed Rank test.

Results

A total of 120 patients, 102 men and 18 women, with a mean age of 50.1 years, met the criteria of OSAS, diagnosed by polysomnography and Epworth Sleepiness Scale, and underwent sleep endoscopy under midazolam or propofol sedation. The mean AHI and BMI were 22.8 and 28.2, respectively.

Of the 120 subjects, 67 (55.8%) patients were position dependent (PP) and 53 (44.2%) were non-positional patients (NPP). In the position dependent group, a total of 60 patients (89.6%) had an AHI < 20 in the non-supine position. Table 1 shows how position dependency is related to age, BMI and AHI. The PP group was significantly younger; the difference in mean age between the two groups was 6.7 years. Although BMI and AHI were slightly higher in the non-positional group, these differences were not significant. However, there were significant differences between the AHI in supine position and the mean AHI of the other positions between the NPP and the PP group.

Table 1 Position dependency in relation to age, BMI, AHIav, AHI supine and AHIav in other positions

Variable	NPP/PP	*N*	Mean	SD	Wilcoxon *P*-value
Age	NPP	53	53.9	11.0	
	PP	67	47.1	11.5	
	Diff (1–2)		6.7	11.3	0.0040
BMI	NPP	53	28.6	4.8	
	PP	67	27.9	3.4	
	Diff (1–2)		0.7	4.1	0.5709
AHIav	NPP	53	24.7	16.3	
	PP	67	19.1	9.6	
	Diff (1–2)		5.7	12.9	0.1018
AHI supine	NPP	53	23.1	23.2	
	PP	67	43.0	19.4	
	Diff (1–2)		–19.9	21.1	< 0.0001
AHI other positions	NPP	53	23.9	15.3	
	PP	67	8.2	7.9	
	Diff (1–2)		15.8	11.8	< 0.0001

PP position-dependent patients, *NPP* non-position dependent patients, *Diff* difference, *AHIav* average AHI

The PP group has a significantly higher AHI in the supine position than the NPP group, while the NPP group has a higher average AHI in the other positions. Figure 1 shows the mean AHI of all different positions for the NPP and PP group. In Fig. 2 the extent of the differences between the AHI in supine position and the average AHI of the other positions divided in the PP and NPP group are shown.

A comparison of sleep parameters is shown in Table 2. There is no difference in total sleep time (TST) between the groups. However, the TST in supine position differed significantly. The average time in supine position was 37 min longer in the PP group. The percentage of REM sleep is equal for the groups. The REM index (AHI in REM sleep) is significantly higher in the NPP group and although there is no significance, the mean oxygen saturation in this group is lower.

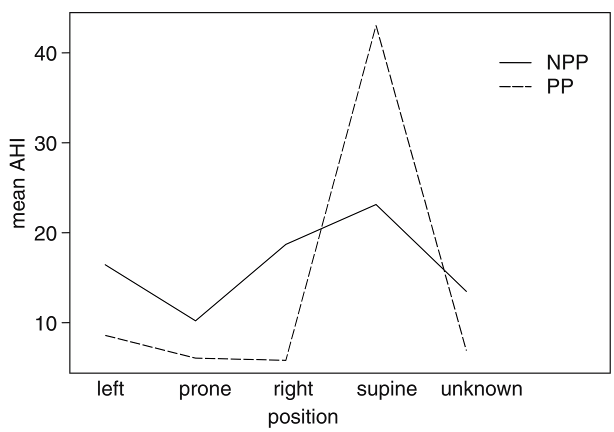

Fig. 1 Mean AHI of NPP and PP for different positions

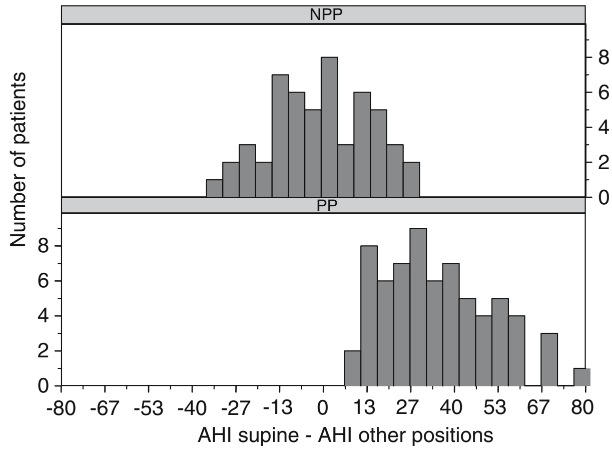

Fig. 2 Difference between AHI in supine position and mean AHI of the other positions

The mean REM index is 25.7 and the mean NREM index 21.2. The overall REM index is significantly higher than the NREM index ($P = 0.0204$).

The level of obstruction did not differ significantly, although there were more patients with obstruction at tongue base level in the PP group (Table 3).

Table 2 Comparison of sleep parameters between the NPP and PP group

Variable	NPP (n = 53)	PP (n = 67)	Wilcoxon *P*-value
TST total	367.5	404.5	0.2276
TST supine	98.9	136.1	0.0132
TST other positions	268.6	268.3	0.9979
% REM	20.5	21.0	0.8043
REM index	30.8	21.7	0.0181
NREM index	22.6	20.1	0.7180
Mean SaO_2 REM	94.3	95.1	0.0551

TST total sleep time (min), *REM index* AHI in REM sleep, *NREM index* AHI in NREM sleep, *SaO_2* oxygen saturation

Table 3 Level of obstruction

Frequency row Pct	Level of obstruction			Total
	Multilevel	Palatinal	Tongue base	
NPP	28	21	4	53
	52.8	39.6	7.6	100
PP	30	24	13	67
	44.8	35.8	19.4	100
Total	58	45	17	120

Multilevel palatinal and tongue base

Discussion

In the present study 55.8% of the 120 patients had position dependent OSAS. Arbitrarily, we defined position dependent OSAS as an at least two times higher AHI in supine position than the mean AHI in the other positions. Oksenberg et al. [18] found a remarkably similar percentage (55.9% positional OSAS) in a series of 574 patients. BMI and AHI were higher in our non-positional group, although not significantly. In their series the BMI and the AHI were significantly higher in the NPP group. Similar to their series, our patients with positional OSAS were significantly (6.7 years) younger than non-positional patients.

We found that in mild to moderate OSAS, position dependency is common; in severe OSAS non-position dependency occurs relatively more frequently. It is tempting to postulate that in the continuum of mild to moderate to severe OSAS, the etiologic role of body position during sleep gradually changes. Apparently, with increasing AHI, turning to the lateral position is not efficient anymore. Cartwright et al. [17] showed that patients with positional sleep apnea prefer the lateral position over the supine position in REM sleep. It is remarkable that in our study PP patients sleep significantly longer (37 min) in supine position. We found that overall, the AHI in REM sleep is significant higher than in non-REM sleep. A lower percentage of REM sleep in the PP group is a possible reason that PP sleep longer on their back, but in this study we found no difference in the percentage REM sleep between the groups. What we did see is that the oxygen saturation in REM sleep, although not significant, is lower in the NPP group.

Body position shifts from the supine to the lateral position is more effective for non-obese than for obese patients [16, 18, 20, 21]. Nevertheless, even NPP benefit of sleeping in the lateral position since the severity of the apneic events occurring while sleeping in the lateral position is less than in the supine position [19].

Ours is the first study in which the level of obstruction in the upper airway (retropalatal vs retrolingual or both) is associated with body posture during sleep. We routinely perform sleep endoscopy with midazolam or propofol in patients with OSAS in whom surgery is considered [23, 24]. We hypothesized that in patients with retrolingual obstruction, more position dependency would occur, but this was not the case. Although there were indeed more patients with obstruction at tongue base level in the PP group (Table 3), the level of obstruction (retropalatinal vs retrolingual vs multilevel) did not differ significantly.

Positional therapy can be defined as preventing patients to sleep in supine position. Patients are often advised to stitch a tennis ball in the back of their pyamas, but the adherence to this kind of intervention is poor, probably because it is uncomfortable, and in practice this kind of advice is rarely followed. In the present observational study, the effectiveness of such intervention was not investigated. It is surprising that given the considerable influence of sleep position on the severity of OSA, so little effort is put in developing effective and comfortable-to-wear devices that influence sleeping posture. We found that 89.6% of the PP had a mean AHI < 20 in non-supine position. Some devices as special pillows are on the market, but the effect of these have not been tested. Recently, Maurer et al. [22] tested the efficacy of a vest preventing the supine position in a group of only 12 patients. Nine patients (75%) were cured (AHI < 10, AHI reduction > 50%), two (17%) patients improved (AHI reduction > 50%) and one patient remained unchanged. The TST at an oxygen saturation below 90% was reduced from 11.7 to 1.5.

Conclusion

Our data confirm the important role of body posture during sleep on the occurrence and severity of sleep apnea. In a selected group of patients, prevention of sleeping in supine position could seriously decrease the AHI. In positional OSAS, the potential role of positional therapy is insufficiently investigated. It is postulated that positional therapy could be of value both as single treatment in simple snoring and mild OSAS, and could be used as additional treatment to standard therapies in more severe cases as well.

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