CHEST
Official publication of the American College of Chest Physicians

CHEST ONLINE

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Chest 2005;128;2130-2137
DOI 10.1378/chest.128.4.2130

ISSN:0012-3692

Prevalence of Positional Sleep Apnea in Patients Undergoing Polysomnography*

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Study objectives: **The primary aim of this study was to determine the prevalence of positional obstructive sleep apnea using a functional definition. Positional sleep apnea was defined as a total apnea-hypopnea index (AHI) $\geq$ 5 with a > 50% reduction in the AHI between the supine and nonsupine postures, and an AHI that normalizes (AHI < 5) in the nonsupine posture. A secondary aim was to determine if positional sleep apnea can be diagnosed accurately during a split-night study.**

Design: **Retrospective chart review.**

Setting: **Two sleep centers in Buffalo, NY, one a Veterans Affairs Western New York Healthcare System Sleep Center (VAWNY) and the other a freestanding ambulatory center (Associated Sleep Center [ASC]).**

Patients: **Three hundred twenty-six patients from the VAWNY, including 57 patients who underwent a split-night study and 242 patients from the ASC who underwent polysomnography.**

Interventions: **None.**

Measurements: **Patient characteristics and sleep study results.**

Results: **Positional sleep apnea was seen in 49 of 99 patients (49.5%) with mild sleep apnea (AHI, 5 to 15/h), 14 of 72 patients (19.4%) with moderate sleep apnea (AHI, 15 to 30/h), and 5 of 77 patients (6.5%) with severe sleep apnea (AHI > 30/h). Sufficient sleep (> 15 min) in both postures was not seen in 104 of 269 patients (38.7%) and 80 of 242 overnight studies (33.1%) at the VAWNY and ASC, respectively, and was not seen in 47 of 57 split-night studies (82.5%). The percentage of studies with insufficient sleep in both postures was significantly greater for split-night studies ($p < 0.0001$).**

Conclusions: **Positional sleep apnea is common particularly in patients with mild disease. Positional sleep apnea cannot usually be assessed during a split-night study.**

(CHEST 2005; 128:2130–2137)

Key words: body posture; breathing disturbances; human sleep; obstructive sleep apnea; polysomnography; sleep apnea; sleep disorders; sleep position

Abbreviations: AHI = apnea-hypopnea index; ASC = Associated Sleep Center; BMI = body mass index; CI = confidence interval; CPAP = continuous positive airway pressure; OSA = obstructive sleep apnea; REM = rapid eye movement; VAWNY = Veterans Affairs Western New York Healthcare System Sleep Center

Body position during sleep influences the frequency of apneas and hypopneas in 50 to 60% of individuals with obstructive sleep apnea (OSA).[1–5] In such cases, the apnea-hypopnea index (AHI) is increased in the supine posture and lower in the lateral posture. Positional sleep apnea is said to be present when there is a 50% reduction in the AHI during nonsupine sleep.[2,5,6] Continuous positive airway pressure (CPAP) is a highly effective form of therapy for OSA. However, acceptance and compliance with CPAP are less than ideal.[7] As an alternative to CPAP, patients with positional sleep apnea may be candidates for therapies that are designed to prevent the supine posture during sleep, *ie*, positional therapy.[5] However, positional therapy is not likely to relieve symptoms if the AHI in the nonsupine position remains elevated. A more clinically appropriate definition would define positional sleep apnea when the rate of the AHI falls below the diagnostic threshold during sleep in the nonsupine posture. Thus, if positional therapy were totally effective in eliminat-

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Manuscript received December 7, 2004; revision accepted April 25, 2005.

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ing sleep in the supine position, the AHI would be normalized and positional therapy alone could be used for treating OSA in these patients.

The prevalence of positional sleep apnea as defined above is not known. Various estimates indicate that positional therapy alone could be used to treat approximately 30 to 50% of all patients with OSA.[8,9] The studies on which this value is based are relatively small and to our knowledge have only been published in abstract or letter form.

The primary aim of this report is to determine the prevalence of positional OSA defined as a total AHI $\geq$ 5 with a > 50% reduction in the AHI between the supine and nonsupine postures and an AHI that normalizes (AHI < 5) in the nonsupine position. Secondary aims were to determine if positional sleep apnea as defined above can be diagnosed accurately during a combined diagnostic and CPAP titration study (split-night testing) and to compare anthropomorphic and polysomnographic data between patients who do and do not meet this definition of positional sleep apnea.

Materials and Methods

Subjects

The sleep records of consecutive patients referred for overnight polysomnography to rule out OSA at the Veterans Affairs Western New York Healthcare System Sleep Center (VAWNY) from January 8, 2001, to November 12, 2002, and from an Associated Sleep Center (ASC) from March 6, 2003, to August 8, 2003, were reviewed for study. Two hundred sixty-nine patients who underwent all-night diagnostic polysomnography and 57 patients who underwent a combined diagnostic and CPAP titration split-night study from the VAWNY sleep center and 242 patients from the ASC who underwent diagnostic polysomnography alone comprised the sample of records for the study. Patients with split-night studies at the ASC were not included since the way in which the data were collected digitally made it difficult to separate the diagnostic from the therapeutic portion of the study when addressing postural effects. Studies that did not include at least 15 min of data in both the supine and nonsupine postures were excluded from analysis. At both sleep centers, patient demographics were recorded. At the VAWNY, the Epworth sleepiness scale and neck circumference were obtained in all patients on the night of the sleep study. The Institutional Review Boards of the VAWNY and the University of Buffalo approved the study.

Polysomnography

Standard overnight polysomnography included recordings of EEG, electro-oculogram, submental and bilateral leg electromyograms, and ECG. Airflow was measured by a nasal pressure transducer (VAWNY: Pro-flo plus; Pro-Tech; Mukiteo, WA; and ASC: Ultima pressure transducer; Braebon; ON, Canada) and respiratory effort by thoracoabdominal piezoelectric belts. Measurement of arterial oxyhemoglobin saturation was performed with a pulse oximeter (VAWNY: Nonin 8600M; Nonin Medical; Plymouth, MA; and ASC: Nellcor N-200; Nellcor Puritan Bennett; St Louis, MO) with the probe placed on the patient's finger. All signals were collected and digitized on a computerized polysomnography system (VAWNY: Sandman; Nellcor Puritan Bennett; Ottawa, ON, Canada; and ASC: Rembrandt; Aerosep Corporation; Buffalo, NY).

Body position was confirmed by direct observation of the patient by the technician using a low-light camera. Each technician was responsible for monitoring of one or two sleeping patients. The camera monitors were placed side by side in the control room to allow simultaneous visualization of the patient's body position. If the technician missed a change in patient posture, the digital recording was backtracked and posture tag was placed (to denote a change in posture) when gross movement artifact was seen on the sleep record. At the VAWNY, a videotape recording of the patient synchronized to the sleep digital recording was obtained in all patients. The scoring technician then rescored the record using the videotape recording to determine the time in each sleep posture. In 10 patients, an epoch-by-epoch comparison of scoring was calculated based on direct observation of the patient by the nighttime technician and a scoring from the videotape record.

Sleep stages were scored in 30-s epochs according to the Rechtschaffen and Kales[10] sleep scoring criteria. Each epoch was analyzed for the number of apneas and hypopneas when an apnea was defined as the absence of airflow for > 10 s. An obstructive apnea was defined as the absence of airflow in the presence of rib cage and/or abdominal excursions, and a central apnea was defined as the absence of both airflow and rib cage and abdominal excursions. Events were scored as hypopneas when a visible reduction in airflow lasting at least 10 s was associated with either a 4% decrease in arterial oxyhemoglobin saturation or when an EEG arousal occurred. An arousal was defined according to the criteria proposed by the Atlas Task Force.[11] The AHI was defined as the number of apneas and hypopneas per hour of sleep. A sleep study finding for OSA was considered positive when the AHI was $\geq$ 5/h.[12] As recommended by the American Academy of Sleep Medicine task force, the severity of sleep apnea was classified as mild if the AHI ranged from 5 to 15/h, moderate when the range was 15 to 30/h, and severe when the AHI was > 30/h.[12] Each epoch was classified as being either in the supine or nonsupine postures (prone or lateral) and if there was a > 50% reduction in the AHI between the supine and nonsupine postures and the AHI in the nonsupine posture was < 5/h, the patient was identified as having positional sleep apnea. Sleep records were initially scored by a certified sleep technologist and then reviewed by an American Board of Sleep Medicine-certified sleep physician. Patients at the VAWNY are offered split-night studies if their AHI during the initial portion of the study (a minimum of 2 h of recording) was > 40/h or from 20 to 40/h if the patient was coming from a considerable distance.

Statistical Analysis

Descriptive statistics were performed. Data are expressed as mean $\pm$ SD. Means were compared using Student t test and Mann-Whitney test when the data were not normally distributed. Proportions were analyzed using χ^2 analysis with Yates continuity correction or Fisher Exact Test when appropriate.

Results

The prevalence of positional sleep apnea at the two centers is shown in Table 1 and Figure 1. Not surprisingly, the percentage of studies in which

Table 1—*Positional Sleep Apnea**

Variables	VAWNY (n = 326) Full Night	Split Night	ASC (n = 242)
Patients assessed for eligibility	269	57	
Insufficient sleep in both postures	104 (38.7)	47 (82.5)†	80 (33.1)
Negative sleep study results	48	0	31
Positive sleep study results	117	10	131
Positional sleep apnea	41/117 (35.0%)‡	1/10 (10.0)	27/131 (20.6)
Positional mild sleep apnea	32/54 (59)	0/0	17/45 (37.8)
Positional moderate sleep apnea	6/31 (19.4)	1/2 (50)	8/41 (19.5)
Positional severe sleep apnea	3/32 (9.4)	0/8 (0)	2/45 (4.4)

*Data are presented as No., No. (%), or No./total patients (%).
†Significance difference from full-night VAWNY and ASC.
‡Significant difference from split-night VAWNY and full-night ASC.

positional sleep apnea could not be evaluated was significantly greater during split-night studies ($p < 0.0001$) than during a full diagnostic night study. Positional sleep apnea was more common in VAWNY patients who underwent full-night studies compared to ASC patients. However, when patients were classified according to sleep apnea severity, there were no differences in the prevalence of positional sleep apnea between the two centers. Positional sleep apnea was significantly more common in patients with mild sleep apnea at both centers. For VAWNY patients, positional sleep apnea was seen more commonly in the patients with milder disease ($p < 0.01$) compared to those with moderate or severe disease. For ASC patients, positional sleep apnea was seen more commonly in the patients with milder disease compared with those with severe disease ($p < 0.01$) and those with moderate disease

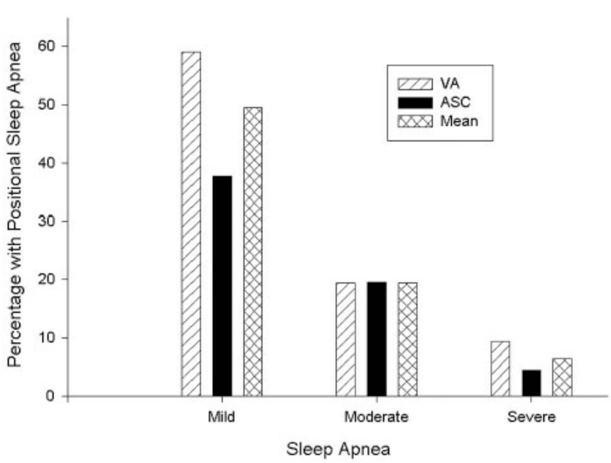

FIGURE 1. Percentage of patients with mild, moderate, and severe sleep apnea with positional sleep apnea from the VAWNY (VA; closed bar), ASC (open bar), and combined (dashed bar). Positional sleep apnea was significantly more common in patients with mild sleep apnea compared to patients with moderate or severe sleep apnea.

($p = 0.052$). Positional sleep apnea was seen more commonly in patients with moderate disease compared with those with severe disease ($p < 0.05$).

Pooling the two centers, positional sleep apnea was relatively common, being seen in 68 of 248 patients (27.4% 95% confidence interval [CI], 21.9 to 33.0%) with an AHI ≥ 5/h in whom sufficient sleep in both postures was observed. Positional sleep apnea was seen in 49.5% (95% CI, 39.3 to 59.7%) when sleep apnea was mild, 19.4% (95% CI, 11.1 to 30.5%) when it was moderate, and 6.5% (95% CI, 2.1 to 14.5%) when it was severe.

When the data were reanalyzed using a minimum of 30 min in each posture, the overall results were not altered except for increasing the number of patients who did not meet the required amount of sleep in both postures. For the VAWNY, 96 patients with sleep apnea had at least 30 min of sleep in both postures. Of these, positional sleep apnea criteria were met in 35 of 96 patients (36.5%), compared to 41 of 117 patients (35.0%) when a 15-min threshold for sleep in both postures was used. Positional sleep apnea was seen in 26 of 42 patients (61.9%) compared with 32 of 54 patients (59%) of patients with mild sleep apnea; 6 of 29 patients (20.7%) compared with 6 of 31 patients (19.4%) of patients with moderate sleep apnea; and 3 of 25 patients (12%) compared to 3 of 32 patients (9.4%) of patients with severe sleep apnea. For the ASC, 118 patients with sleep apnea had at least 30 min of sleep in both postures. Positional sleep apnea was seen in 25 of 118 patients (21.2%) compared with 27 of 131 patients (20.6%) when a 15-min threshold for sleep in both postures was used. Positional sleep apnea was seen in 15 of 41 patients (36.6%) compared with 17 of 44 patients (37.8%) with mild sleep apnea; 8 of 38 patients (21.2%) compared with 8 of 41 patients (19.5%) with moderate sleep apnea; and 2 of 39 patients (5.1%) compared to 2 of 45 patients (4.4%)

with severe sleep apnea. None of these comparisons was statistically significant.

Patient Characteristics

The clinical characteristics of the positional and nonpositional groups are shown in Table 2. The groups were similar in terms of age, gender, weight, height, body mass index (BMI), and Epworth sleepiness scale score. However, the nonpositional sleep apnea group had a larger neck circumference compared to the positional group ($p = 0.009$). At the VAWNY, there was a significantly larger proportion of male subjects and the patients were significantly older but had similar BMIs compared to the patients at the ASC.

Nocturnal Polysomnographic Data

Sleep data are shown in Figures 2 and 3. Patients with nonpositional sleep apnea had more severe sleep apnea (Fig 2). In the supine posture, the AHI (mean ± SD) was significantly higher in the nonpositional patients compared to the patients with positional sleep apnea (VAWNY, 44.7 ± 28.8 events per h vs 29.5 ± 23.0 events per h [$p = 0.004$]; and ASC, 45.2 ± 32.7 events per h vs 29.0 ± 25.4 events per h, $p = 0.019$, respectively). Patients with positional sleep apnea spent more time in the supine posture as a percentage of the total sleep time than patients with nonpositional sleep apnea (VAWNY, 48.1 ± 23.1% vs 37.5 ± 22.8%, $p = 0.02$; and ASC, 51.9 ± 24.3% vs 35.3 ± 21.1%, $p = 0.002$ respectively).

Negative Sleep Study Results

Sixteen of 48 negative study results (33%; 95% CI, 20.4 to 48.4%) at the VAWNY and 7 of 31 negative study results (23%; 95% CI, 9.6 to 31.1%) at the ASC had a positional component, where although the overall AHI was < 5/h, the supine AHI was ≥ 5/h and more than twice the nonsupine AHI. Patients with a positional component tended to spend less time in the supine posture as a percentage of the total sleep time than did patients with purely negative study results (VAWNY, 31.2 ± 20.3% vs 46.2 ± 25.7%, $p < 0.05$; and ASC, 31.0 ± 19.5% vs 41.2 ± 20.3%, p = not significant) or patients with positional sleep apnea (VAWNY, 31.2 ± 20.3% vs 48.1 ± 23.1%, $p < 0.01$; and ASC, 31.0 ± 19.5% vs 51.9 ± 24.3%, $p < 0.02$).

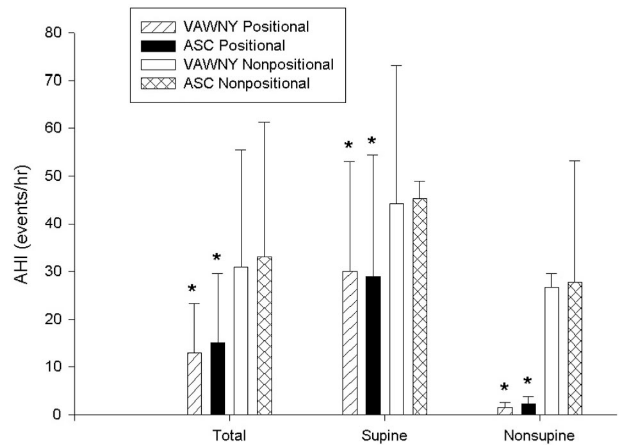

FIGURE 2. Total, supine, and nonsupine AHI for patients with positional and nonpositional sleep apnea from the VAWNY and ASC sleep centers. Patients with nonpositional sleep apnea had a significantly greater AHI (total, supine, and nonsupine) than those with positional sleep apnea. *Significant difference from nonpositional sleep apnea.

Validation of Posture Monitoring

There were 62 posture transitions from the nonsupine to supine postures during sleep in the 10 patients. Mean number of transitions per patient was 6.2 ± 3.7 (range, 1 to 11 transitions). For 59 of the 62 transitions, the nighttime technician scored the transition during the same epoch as was determined from the videotape recording. In three transitions, the nighttime technician scored the transition 2, 3, and 4 epochs later than was identified from the

Table 2—*Patient Characteristics**

Characteristics	VAWNY Positional (n = 41)	VAWNY Nonpositional (n = 76)	VAWNY p Value	ASC Positional (n = 27)	ASC Nonpositional (n = 04)	ASC p Value
Age, yr	55.4 ± 13.8	59.2 ± 12.4	0.141	46.3 ± 14.5	48.8 ± 11.7	0.357
Male/female gender, No.	39/2	75/1	0.582	15/12	61/43	0.943
Weight, kg	97.0 ± 19.7	102.9 ± 21.7	0.133	91.7 ± 18.6	100.0 ± 26.2	0.290
Height ,cm	176.7 ± 7.8	176.6 ± 8.3	0.815	169.9 ± 10.6	172.5 ± 10.8	0.273
BMI, kg/m^2	30.8 ± 5.7	32.8 ± 6.6	0.185	31.6 ± 5.1	33.1 ± 8.1	0.418
Neck circumference, cm	41.7 ± 3.7	43.4 ± 4.5	0.009			
Epworth sleepiness scale score	12.1 ± 5.4	11.8 ± 5.9	0.797			

*Data are presented as mean ± SD unless otherwise indicated.

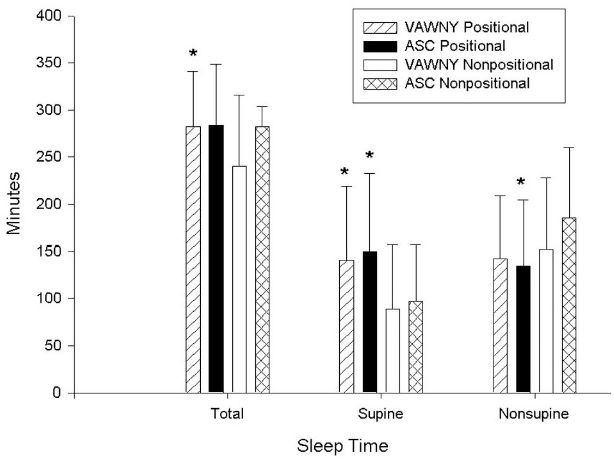

FIGURE 3. Sleep times for patients with positional and nonpositional sleep apnea from the VAWNY and ASC. Patients with positional sleep apnea spent more time supine than patients with nonpositional sleep apnea. *Significant difference from nonpositional sleep apnea.

videotape recording. Thus, posture scoring obtained by real-time scoring by the nighttime technician agreed with that obtained by review of the videotape recording for 7,757 of 7,766 epochs (99.9%).

Discussion

Positional sleep apnea as defined by a > 50% reduction in the AHI between the supine and nonsupine postures, and an AHI in the nonsupine posture < 5/h was relatively common, being identified in 68 of 248 patients (27.4%) with an overall AHI ≥ 5/h in whom sufficient sleep in both postures was observed. Positional sleep apnea was significantly more common when sleep apnea was mild (49.5%) than when it was moderate (19.4%) or severe (6.5%). When split-night studies were performed, sufficient sleep in both postures was rarely observed, making it impossible to assess for a positional component in most cases. When patients with positional sleep apnea and nonpositional sleep apnea were compared, patients with positional sleep apnea had a lower AHI, had a smaller neck circumference, and spent more time in the supine posture as a percentage of total sleep time.

Technical Considerations

The diagnostic threshold for determining a positive sleep study result remains controversial. An AHI ≥ 5/h is an accepted definition for a positive sleep study,[12] but some sleep centers use a more conservative diagnostic threshold of 10/h or even 15/h. In this study, patients were categorized as mild (5 to 15/h), moderate (15 to 30/h), or severe (> 30/h) according to the American Academy of Sleep Medicine task force position.[12] For those clinicians who use a threshold value of ≥ 15/h, the prevalence of positional sleep apnea can be evaluated by looking at the data for those patients classified with moderate and severe sleep apnea.

Determining positionality depends on an accurate recording of sleep posture. Various digital position monitors proved to be disappointing in their accuracy compared to direct review of videotape recordings of the patient. In contrast, real-time posture scoring by the nighttime technicians appeared to be highly accurate. Technicians in our laboratories monitor one to two patients per night. Thus, it is inevitable that they will sometimes miss the exact time that the patient switches posture. When this happened, the digital record is backtracked and the posture tag is placed at the start of the nearest gross movement artifact, reasoning that this was likely where the patient changed position. Direct comparison of real-time posture scoring with videotape recording suggests that this assumption was usually correct and that real-time observation of the patient by the nighttime technician can be an acceptable method for posture scoring.

There is no generally accepted minimum time in which to assess positional differences. We chose a requirement of 15 min in each posture. There is some debate about whether this is too little time to assess postural differences accurately. However, a reanalysis of the data using a minimum of 30 min in each posture (used by some prior investigators in the field[1]) did not alter the main findings except for increasing the number of patients with insufficient sleep in both postures.

In our study, we defined hypopnea as a visible reduction in airflow associated with either a 4% reduction in oxygen saturation or an arousal. Research studies and Medicare guidelines have defined hypopnea using only the desaturation criteria.[13] This decision was made because the interobserver correlation for scoring of arousals was not as high as for other polysomnographic variables.[14,15] This may impact the overall AHI and influence the incidence of positional sleep apnea if the number of patients with mild sleep apnea is thereby reduced.

In our study, we assessed nasal airflow with a pressure transducer rather than with thermistors or thermocouples. Nasal pressure provides a more sensitive index of airflow and thus a more accurate estimate of AHI.[16] It is possible that some of our patients designated as having mild sleep apnea would have been classified as negative using thermistors, and this too could influence the incidence of positional sleep apnea if the percentage of patients with mild sleep apnea is reduced. In addition, there are some data suggesting that patients spend more time in the supine posture during polysomnography compared to home sleep.[17,18] This also could influence the classification of severity of sleep apnea in patients with positional sleep apnea.

We assessed the prevalence of positional sleep apnea in two separate sleep centers serving very different patient populations. Patients at the VAWNY were older and predominantly male. Despite these differences in patient characteristics, the conclusions of our study applied to both populations supporting the generalizability of our findings.

In our sleep centers, we do not wake patients up to request supine sleep as is done in some sleep centers, if the patients do not spontaneously sleep in the supine posture. In our study 184 of 511 patients undergoing overnight polysomnography (36.0%; 95% CI, 31.8 to 40.2%) did not have sufficient sleep in both postures. Of these patients, 29.3% did not have sufficient nonsupine sleep and 70.7% did not have sufficient sleep in the supine posture. As mentioned above, there is some evidence that patients sleep more in the supine posture during polysomnography than they do at home, and this difference will be accentuated by requesting supine sleep during polysomnography in those who do not adapt the supine posture spontaneously. However, in our sample 25% of patients did not spontaneously sleep in the supine posture for a sufficient period of time, and this percentage could presumably be substantially reduced if patients were awakened to request supine sleep, thus reducing the number of studies in which a positional component could not be determined.

Split-Night Studies

In our study, in 47 of 57 split-night studies (82.5%) there was not sufficient sleep time in both postures during the diagnostic portion of the study to evaluate the presence of a positional component. Fourteen patients had insufficient sleep in the supine posture that may not be that clinically important since they already had an elevated AHI in the nonsupine posture. However, the other 33 patients had insufficient sleep in the nonsupine posture (33 of 57 patients, 58%), and in these patients clinically relevant positional sleep apnea can be missed. Thus, there is an opportunity cost when doing a split-night study. It is very unlikely that this would be different in laboratories that request supine sleep, since the technicians generally request supine sleep when the study result is relatively negative and there has been little supine sleep, while split-night studies are only done on patients with grossly positive sleep study results. However, the threshold for determining when a split-night study will be performed will clearly influence how many patients with positional sleep apnea will be missed. The incidence of positional sleep apnea is relatively uncommon (6.5%; 95% CI, 2.1 to 14.5%) in patients with severe sleep apnea. Thus, the number of patients in whom a significant positional component will be missed will be relatively small if only patients with severe sleep apnea undergo split-night studies as is currently the case in most sleep centers. However, if sleep centers loosen these criteria to include patients with moderate sleep apnea, the number of patients in whom positional sleep apnea is missed will increase as the incidence of positional sleep apnea in patients with moderate disease was 19.4% (95% CI, 11.1 to 30.5%).

Negative Sleep Studies Results

Twenty-three of 79 patients (29%; 95% CI, 19.4 to 40.4%) with an AHI < 5/h had an AHI in the supine posture that was > 5/h and was twice that in the nonsupine posture. Patient characteristics did not distinguish those patients with a positional component from those without. However, patients with a positional component had a lower percentage time spent in the supine posture compared to nonpositional-negative patients and more importantly compared to those patients with a positional component and a positive study result. Thus, to a certain extent the major difference between those patients with positional sleep apnea and these negative patients with a positional component was that they did not spend enough time in the supine posture to have an overall AHI > 5/h. How representative the time spent in the supine posture during an overnight study in the sleep laboratory is to the patient's usual sleep habits is unknown. Furthermore, the extent to which during a repeat sleep study, some patients with mild positional sleep apnea would switch into the negative category and *vice versa* as the time spent in the supine posture varies needs to be determined. Whether patients with an overall AHI < 5/h but a positional component would symptomatically respond to primary treatment for sleep apnea also needs to be determined. However, avoidance of the supine posture would appear to be a potentially effective therapy in such patients.

Comparison to Prior Studies

Prior studies have classified positional sleep apnea as an AHI in the supine posture that was twice that in the nonsupine posture. Using this definition, approximately 50 to 60% of patients with sleep apnea were classified as positional.[1–6] When we utilized this definition, 143 of 248 evaluable patients (57.7%; 95% CI, 51.5 to 63.8%) met the definition for positional sleep apnea, suggesting we were studying a similar population of patients. In the largest study[1] examining this issue in 574 patients, variables that distinguished positional from nonpositional patients were the overall AHI, BMI, and to a lesser extent age. Using our definition, the incidence of positional sleep apnea was decreased (27.4%). However, we also found that the overall AHI was the most important predictor for positional sleep apnea, with patients with milder disease being more likely to demonstrate positional sleep apnea. Even when the severity of the AHI was compared for both groups in the supine posture, patients with positional sleep apnea had a significantly lower AHI than patients with nonpositional sleep apnea at both sleep centers (VAWNY, 29.5 ± 23.0 events per hour vs 44.7 ± 28.8 events per h [$p = 0.004$]; and 29.0 ± 25.4 events per h vs 32.7 events per h [$p = 0.019$], respectively). We also found that a marker of obesity, neck circumference, distinguished between those with and without positional sleep apnea. Age was not a significant predictor in our study. However, the difference in age between the patients with and without positional sleep apnea in our study was of a similar magnitude as that observed in the prior study where statistical significance was reached. Thus, this difference in significance may be attributed to the larger number of patients in the prior sample or a true difference related to the different definition for positional sleep apnea.

The AHI is influenced by sleep stage being higher in rapid eye movement (REM) sleep than during non-REM sleep. The effects of sleep staging on positional dependency have been investigated previously with conflicting results.[4,19,20] In our study, the minority of patients with positional sleep apnea had sufficient sleep (15 min) in both postures during both non-REM and REM sleep: 6 of 27 patients from the ASC and 8 of 41 patients from the VAWNY. In these patients, the AHI during REM sleep was significantly less in the nonsupine posture compared to the supine posture, 10.3 ± 9.5 vs 33.9 ± 27.1 for the VAWNY ($p < 0.02$) and 3.4 ± 3.6 vs 45.7 ± 28.1 for the ASC ($p < 0.02$). In individual patients, a 50% reduction in the AHI during REM sleep in the nonsupine posture (compared to supine REM sleep) was seen in five of eight VAWNY patients and five of six ASC patients. Our results are consistent with the results of some[4,20] but not all prior studies.[19] However, the latter study[19] examined only a small number of obese patients ($n = 7$) with very severe sleep apnea.

There are limited data available on the effects of positional therapy in patients with sleep apnea. To our knowledge, there are no studies comparing patients receiving positional therapy to a placebo group. There is one small (13 subjects) crossover study[21] comparing positional therapy to nasal CPAP in patients with mild-to-moderate disease. There is one study[5] comparing positional therapy ($n = 30$) to a tongue-retaining device. There is reasonable evidence that positional therapy can be effective at eliminating supine sleep and that this can significantly reduce the overall AHI.[5,21–24] However, data on the effects of positional therapy on subjective and objective sleepiness, quality of life, and other important outcome measures are very limited. One small study[25] demonstrated that positional therapy can reduce 24-h BP in normotensive ($n = 7$) and hypertensive ($n = 6$) patients with positional sleep apnea. In the crossover study[21] comparing positional therapy to nasal CPAP, although nasal CPAP was more effective at reducing the AHI, there were no differences in subjective or objective sleepiness between the two therapies.

In conclusion, positional sleep apnea is common particularly in patients with milder disease who have smaller neck circumferences. Positional therapy has the potential to be an effective therapy in a significant proportion of patients with sleep apnea. Rigorous outcome studies evaluating the efficacy of this treatment modality are urgently needed in patients with mild-to-moderate sleep apnea.

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