Does Obstructive Sleep Apnea Confound Sleep Architecture Findings in Subjects with Depressive Symptoms?

Wayne A. Bardwell, Polly Moore, Sonia Ancoli-Israel, and Joel E. Dimsdale

Background: Compared with normal subjects, depressed patients have shorter rapid eye movement sleep latency (REML), increased REM and decreased slow wave sleep as a percentage of total sleep time (REM%, SWS%), and longer sleep latency (SL). Obstructive sleep apnea (OSA) patients experience longer REML, decreased REM% and SWS%, and shorter SL. We examined the interplay of depressive symptoms, OSA, and sleep architecture.

Methods: Subjects (n = 106) were studied with polysomnography. OSA was defined as a Respiratory Disturbance Index $\geq 15$. Subjects were divided into Hi/Lo groups using a Center for Epidemiological Studies—Depression (CES-D) score of 16.

Results: OSA patients had shorter SL than non-OSA patients (14.5 vs. 26.8 min, $p < .001$); Hi CES-D subjects showed a trend toward longer SL than Lo CES-D subjects (23.7 vs. 17.5 min, $p = .079$). Significant OSA $\times$ CES-D interactions emerged, however, for REM% ($p = .040$) and SL ($p = .002$): OSA/Hi CES-D subjects had higher REM% than OSA/Lo CES-D subjects (19.3% vs. 14.3%, $p = .021$); non–OSA/Hi CES-D subjects had SL (35.3 min) 2–3 times as long as other subjects ($p = .002–.012$).

Conclusions: Because of the high prevalence of OSA and depression, findings suggest that OSA must be considered in studies of mood and sleep architecture. Conversely, depressive symptoms must be considered in studies of OSA and sleep architecture. Biol Psychiatry 2000;48:1001–1009 © 2000 Society of Biological Psychiatry

Key Words: Depression, mood, obstructive sleep apnea, sleep architecture, REM, sleep latency

Introduction

Sleep disruption has long been recognized as accompanying depression. When compared with the nondepressed, the most frequently reported alterations in sleep architecture in depressed patients include reduced rapid eye movement sleep latency (REML), increased REM as a percentage of total sleep time (REM%), reduced percentage of slow wave sleep (Stages 3 and 4) (SWS%), and increased time to sleep onset (also known as sleep latency)(Benca et al 1992; Gillin et al 1993). During acute illness, some form of sleep abnormality is present in about 90% of depressed patients (Reynolds and Kupfer 1987). In addition, mild levels of obstructive sleep apnea (OSA) have been observed in 15% of inpatients with affective disorders (Reynolds et al 1982).

Table 1 summarizes research documenting alterations in sleep architecture in patients with varying levels of depressive symptoms. The mean REM% in these studies ranged from 17% to 27%, averaging 22%. REML ranged from 46 to 107 min, averaging 67 min. The mean sleep latency recorded in these studies ranged from 11 to 36 min, averaging 24 min. By comparison, normative data based on a sample of subjects free of sleep or alertness complaints and without major medical or psychiatric diagnoses (Doghramyji et al 1997) reveals that REM% averaged 19.27%; REML averaged 106.6 min; SWS% averaged 16.49%; and sleep latency averaged 10.9 min. It is generally accepted that the degree of sleep disruption does not necessarily reflect the severity of the depression; even comparatively mild depressive symptomatology may produce alterations in polysomnographically recorded sleep (Buysse et al 1997; Hauri et al 1974).

An intriguing aspect that has been given little attention in the psychiatric literature is the possibility that coexisting sleep disorders may confound these relationships between depressive symptoms and sleep architecture. In this article, we examined how OSA affected the relationships between sleep architecture and depressive symptoms. Affecting up to 9% of middle-aged adults and higher percentages in the elderly, OSA is a devastating illness (Ancoli-Israel et al 1991; Jenum and Sjol 1992; Jeong and Dimsdale 1989; Young et al 1993) that leaves patients exhausted from sleep deprivation.

The literature is mixed regarding the role played by psychological factors in OSA (for review, see Bardwell et
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<th>Reference</th>
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<tr>
<td>Hubain et al 1998</td>
<td>300 (198 F, 102 M)</td>
<td>Inpatients, drug free, HRSD ≥ 20</td>
<td>NR</td>
<td>F: 74 (60)</td>
<td>M: 17 (7)</td>
<td>Controlled for various confounding factors (such as age, weight loss, severity of depression, etc). Correlations were found with increased waking and decreased SWS, but not with REM latency.</td>
</tr>
<tr>
<td>Thase et al 1998</td>
<td>78 (? f, ? M)</td>
<td>Outpatients, drug free, HRSD ≥ 14</td>
<td>Grp 1: 26 (18)</td>
<td>Grp 1: 63 (17)</td>
<td>Grp 1: 23 (5)</td>
<td>Two groups of depressed patients were classified on the basis of “abnormal” vs. “normal” pretreatment sleep study measures. Certain sleep abnormalities were stable across time (including REM-latency) and after treatment with cognitive behavior therapy; whereas other measures improved (such as sleep efficiency).</td>
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<tr>
<td>Reynolds et al 1990</td>
<td>302 (151 F, 151 M)</td>
<td>Outpatients, drug free, HRSD ≥ 15</td>
<td>F: 23 (27)</td>
<td>F: 64 (30)</td>
<td>M: 23 (6)</td>
<td>Gender-related differences in sleep variables were found for slow-wave sleep measures but not for REM latency.</td>
</tr>
<tr>
<td>Kupfer et al 1981</td>
<td>34 (20 F, 14 M)</td>
<td>Inpatients, drug free, HRSD ≥ 30</td>
<td>36 (3)</td>
<td>46 (4)</td>
<td>25 (1)</td>
<td>Followed patients with various dosages of tricyclic antidepressant, and found that treatment response was associated with changes in REM latency.</td>
</tr>
<tr>
<td>Coble et al 1979</td>
<td>12 (8 F, 4 M)</td>
<td>Nondelusional inpatients, drug free, HRSD ≥ 30</td>
<td>35 (8)</td>
<td>48 (7)</td>
<td>NR</td>
<td>Sleep parameters were examined over time in patients on placebo for 5 weeks. Sleep parameters remained fairly unchanged across time.</td>
</tr>
<tr>
<td>Gillin et al 1978</td>
<td>9 (5 F, 4 M)</td>
<td>Inpatients, moderately to severely depressed</td>
<td>29 (16)</td>
<td>58 (27)</td>
<td>27 (2)</td>
<td>Patients’ sleep was studied prior to treatment with a tricyclic antidepressant, during treatment and during withdrawal from treatment. Patients with clinical improvement showed a significant REM rebound effect during drug withdrawal, but the patients who failed to improve did not. Some sleep abnormalities found to persist in patients who had been remitted for longer than six months. NREM sleep abnormalities (longer sleep latency, decreased SWS) seemed to persist longer than certain of the REM abnormalities.</td>
</tr>
<tr>
<td>Hauri et al 1974</td>
<td>14 patients (10 F, 4 M) and 4 control subjects</td>
<td>Drug-free remitted patients</td>
<td>Patients: 24 (23)</td>
<td>Patients: 90 (25)</td>
<td>Patients: 21 (6)</td>
<td>Some sleep abnormalities found to persist in patients who had been remitted for longer than six months. NREM sleep abnormalities (longer sleep latency, decreased SWS) seemed to persist longer than certain of the REM abnormalities.</td>
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</tbody>
</table>

Values given are means (SD), except where * indicates (SEM). Sleep latency values are in minutes. REM latency values are given in minutes, but may have been defined slightly differently in different studies. F, female; M, male; HRSD, Hamilton Rating Scale—Depression; NR, not reported; SWS, slow wave sleep; KDS, Kupfer–Detre Scale; OSA, obstructive sleep apnea; NREM, non-REM.
al 1999). Nonetheless, many researchers have found associations between OSA and overall psychological distress and, more specifically, clinical depression (Cheshire et al 1992; Guilleminault et al 1977; Millman et al 1989; Reynolds et al 1984) or increased levels of depressive symptoms (Borak et al 1994; Derderian et al 1988; Edinger et al 1994; Engleman et al 1994; Flemons and Tsai 1997; Kales et al 1985; Platon and Sierra 1992). For example, in a study of 25 male patients with sleep apnea, 40% met criteria for an affective disorder or alcohol abuse (Reynolds et al 1984).

Sleep architecture differences in OSA patients contrasted with normal subjects (i.e., compared to Doghramji et al [1997] normative values) have included shorter sleep latency (Fry et al 1989; Hanzel et al 1991; Kass et al 1996; Series et al 1992; Smith et al 1985), increased REM% (Mendelson 1992, 1995; Series et al 1992; Stewart et al 1992), decreased REM% (Colt et al 1991; Chervin and Aldrich 1998; Espinosa et al 1987; Hanzel et al 1991; Mendelson 1992, 1995; Oksenberg et al 1997; Roehrs et al 1989; Series et al 1992; Smith et al 1985; Stewart et al 1992), and decreased SWS% (Weitzman et al 1980; White 1992). With the exception of SWS%, these findings are opposite to those observed in depressed patients.

Table 2 summarizes research documenting sleep architecture in OSA patients. The mean REM latency in these studies ranged from 63 to 175 min, averaging 121 min. OSA patients also tend to experience a lower REM% than normal subjects do. This may simply be a consequence of the impaired sleep continuity and fragmentation of sleep resulting from repetitive airway obstruction. The mean REM% in these studies ranged from 6% to 20%, averaging 14% of total sleep time. In addition, sleep latency in OSA patients tends to be shorter than in normal subjects—probably because of the accumulated sleep debt. The mean sleep latency recorded in these studies ranged from 4 to 24 min, averaging 10 min.

Because the presence of OSA may not be routinely determined in studies of sleep and mood, findings in this area of research may be confounded. Conversely, depressive symptoms may complicate studies of sleep architecture in OSA patients. To our knowledge, no previous studies have examined the potential interaction effect of OSA and depressive symptoms on sleep architecture. We wondered, for example, if the contrasting sleep effects seen in OSA and in depressive symptoms would offset each other or if some other pattern might emerge in patients exhibiting both high levels of depressive symptoms and OSA.

Most previous research into affective disorders and sleep architecture has focused on patients with diagnosed mood disorders. Because of the growing interest in the impact of subclinical levels of depressive symptoms, we wondered if these previously reported findings would hold when dividing patients into high and low depressive symptom groups, regardless of diagnosis. In this study we examined the relationships between sleep latency, REM latency, and REM% versus OSA diagnosis and level of depressive symptoms. We wondered if a diagnosis of OSA would impact these sleep architecture variables in subjects with high levels of depressive symptoms, and if depressive symptoms would impact them in subjects with OSA.

### Methods and Materials

Subjects (n = 106) included 57 men and 10 women with OSA and 27 men and 12 women without OSA. None of the subjects had any other sleep disorder. Subjects ranged from 32 to 64 years of age (Table 3) and were recruited by advertising and word of mouth to participate in our research on sympathetic nervous system physiology in subjects with and without OSA. To qualify, subjects had to be between 100% and 150% of ideal body weight as determined by Metropolitan Life Insurance tables (Metropolitan Life Foundation 1983). Although OSA is more common among the obese, subjects with greater than 150% of ideal body weight were excluded because of the possibility of confounding by other conditions associated with obesity. Subjects were also excluded if they had major medical illnesses other than OSA. Subjects were studied after we had obtained written informed consent. The protocol was approved by the University of California, San Diego, Human Subjects Committee.

Polysomnographic sleep was monitored all night in the Clinical Research Center, and included standard central and occipital electroencephalogram (EEG); bilateral electrooculogram (EOG); submental electromyogram (EMG); airflow, thoracic, and abdominal excursions with Respiritrace respiratory inductive plethysmography (Non-Invasive Monitoring Systems, Miami Beach, FL); and bilateral tibialis EMG. Tracings were scored according to the criteria of Rechtschaffen and Kales (1968) and the number of apnea/hypopnea events was recorded. The majority of subjects had solely obstructive type events; only a few subjects showed evidence of central apneas.

Subjects were classified as having sleep apnea if their Respiratory Disturbance Index (RDI) was 15 or more: in OSA subjects (n = 67), RDI ranged from 15 to 142 (mean = 50.7, SD = 28.7); for non-OSA subjects (n = 39), RDI ranged from 1 to 14 (mean = 5.6, SD = 3.7). Sleep latency was defined as the time from lights out to the first epoch of stage 2 sleep. REM latency was defined as time from the first epoch of stage 2 sleep to the first epoch of REM sleep. REM% and SWS% were calculated by dividing min of REM by total sleep time, and min of stage 3 plus stage 4 sleep by total sleep time, respectively.

Subjects completed the Center for Epidemiological Studies Depression (CES-D) scale (Radloff 1997), a frequently used 20-item self-report measure of depressive symptoms. When used with medically ill patients, depression rating scales are sometimes influenced by symptoms of their illness. For example, mood-related observations in OSA patients could be confounded by the fatigue/sleepiness they experience; however, the CES-D primarily taps the cognitive/affective symptoms of depression.
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<th>Reference</th>
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<th>REM latency</th>
<th>REM%</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Espinoza et al 1987</td>
<td>10 M</td>
<td>NR</td>
<td>11.2 (2.3)</td>
<td>NR</td>
<td>9.6 (2.1)</td>
<td>Compared a 1-night infusion of aminophylline to a placebo infusion night. Aminophylline caused a decrease in central events, but no change in obstructive events and also disturbed sleep efficiency.</td>
</tr>
<tr>
<td>Hanzel et al 1991</td>
<td>7 M, 5 F</td>
<td>NR</td>
<td>4.1 (1.1)</td>
<td>NR</td>
<td>17 (2)</td>
<td>Compared the effect of fluoxetine to protryptiline. Both drugs decreased REM time and number of REM-related respiratory events.</td>
</tr>
<tr>
<td>Fry et al 1989</td>
<td>30 M, 3 F</td>
<td>RDI ≥ 10</td>
<td>7.5 (6.2)</td>
<td>62.8 (20.2)</td>
<td>19.8 (6.0)</td>
<td>Periodic limb movements in OSA were measured at baseline, and with two CPAP recordings. The therapeutic effects of weight loss on OSA were examined.</td>
</tr>
<tr>
<td>Smith et al 1985</td>
<td>13 M, 2 F</td>
<td>RDI ≥ 10</td>
<td>6.9 (1.5)</td>
<td>NR</td>
<td>Approx. 10⁶</td>
<td>OSA patients were compared to patients with central sleep apnea and pathologic snorers (only the OSA data are reported in this table). OSA patients were subjectively sleepier. Hypertension was strongly associated with weight and also with RDI.</td>
</tr>
<tr>
<td>Mendelson 1992</td>
<td>169 M, 23 F</td>
<td>RDI ≥ 5</td>
<td>11.7 (1.5)</td>
<td>134 (6.5)</td>
<td>13.8 (unknown)</td>
<td>OSA patients were compared to patients with central sleep apnea and pathologic snorers (only the OSA data are reported in this table). OSA patients were subjectively sleepier. Hypertension was strongly associated with weight and also with RDI.</td>
</tr>
<tr>
<td>Mendelson 1995</td>
<td>430 M, 88 F</td>
<td>RDI ≥ 5</td>
<td>13.8 (4.6)</td>
<td>131.0 (84.1)</td>
<td>14.4 (unknown)</td>
<td>Compared OSA patients to patients with subclinical sleep-disordered breathing.</td>
</tr>
<tr>
<td>Oksenberg et al 1997</td>
<td>574 patients in 2 groups (G1, G2)</td>
<td>RDI ≥ 10</td>
<td>G1: 12.9 (4.2)</td>
<td>G1: 89.6 (46.6)</td>
<td>G1: 19 (7.4)</td>
<td>OSA patients divided into two groups based on whether or not the RDI was worsened × 2 when positioned supine.</td>
</tr>
<tr>
<td>Series et al 1992</td>
<td>8 M</td>
<td>NR</td>
<td>8.7 (3.0)</td>
<td>149.6 (24.9)</td>
<td>13.4 (1.7)</td>
<td>Administered a short-acting SWS-enhancing drug, γ-hydroxy-butyrate, to see if overall RDI could be improved.</td>
</tr>
<tr>
<td>Stewart et al 1992</td>
<td>8 M</td>
<td>NR</td>
<td>24 (3.3)</td>
<td>175 (32)</td>
<td>13.4 (unknown)</td>
<td>Apnea patients were treated for one week with a nonsteroidal antiandrogen.</td>
</tr>
<tr>
<td>Kass et al 1996</td>
<td>34 (15 M, 19 F)</td>
<td>RDI &lt; 10</td>
<td>8.3 (3.4)</td>
<td>NR</td>
<td>ns</td>
<td>REM RDI correlated with sleepiness measures in patients with mild OSA but worsening during REM.</td>
</tr>
<tr>
<td>Colt et al 1991</td>
<td>7 M</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>6 (5)</td>
<td>No statistically significant differences in MSLT scores after CPAP treatment under hypoxic or nonhypoxic conditions.</td>
</tr>
<tr>
<td>Roehrs et al 1989</td>
<td>415 M, 51 F</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>12.1 (6.4)</td>
<td>Found that the best predictor of MSLT score was the degree of sleep fragmentation during the previous night (i.e., the respiratory arousal index).</td>
</tr>
<tr>
<td>Chervin and Aldrich 1998</td>
<td>814 M, 332 F</td>
<td>RDI ≥ 10</td>
<td>NR</td>
<td>NR</td>
<td>14.2 (6.2)</td>
<td>Concluded that apneic events during both REM and non-REM sleep contribute to sleepiness.</td>
</tr>
</tbody>
</table>

Values given are means (SEM).
Sleep latency values are in minutes. REM latency values are given in minutes, but may have been defined slightly differently in different studies.
OSA, obstructive sleep apnea; M, male; NR, not reported; F, female; RDI, Respiratory Disturbance Index; CPAP, continuous positive airway pressure; SWS, slow wave sleep; MSLT, multiple sleep latency test.

*Value not specified but estimated from figure.

*Value was calculated from given information of total sleep time, or TST (min), and REM sleep (min): (REM min/TST min) × 100 to give % REM.
and has been shown to be useful in chronically ill groups experiencing fatigue (e.g., human immunodeficiency virus [HIV], cancer) (Cockram et al 1999; Hann et al 1999). In a variety of populations, a large percentage of subjects with a score of $\geq 16$ have been shown to meet diagnostic criteria for dysthymia or major depression (Murphy 1982; Schulberg et al 1985). Using this commonly accepted cut-off score, our subjects were divided into Hi/Lo depressive symptom groups. For the Lo CES-D group, scores ranged from 0 to 15 (mean = 4.2; SD = 4.1); for the Hi CES-D group, scores ranged from 16 to 49 (mean = 23.7 vs. 17.5 min, $p = .066$; REM% (17.1% vs. 16.6%, $p = .784$), or SWS% (7.0% vs. 9.6%, $p = .148$). OSA subjects showed significantly shorter sleep latency than non-OSA subjects, however (14.5 vs. 26.8 min, $p = .001$). Similarly, no significant main effects emerged for CES-D Hi/Lo for REML (191.8 vs. 99.6 min, $p = .203$), REM% (17.5% vs. 16.3%, $p = .495$), or SWS% (9.6% vs. 7.0%, $p = .133$); however, Hi CES-D subjects showed a trend toward longer sleep latency than Lo CES-D subjects, (23.7 vs. 17.5 min, $p = .079$).

The OSA $\times$ CES-D interaction was not significant for REML ($p = .066$) or SWS% ($p = .141$); however, significant OSA $\times$ CES-D interactions emerged for both sleep latency ($p = .002$; Figure 1) and REM% ($p = .040$; Figure 2). Post hoc analyses revealed that the sleep latency in non–OSA/Hi CES-D subjects was twice as long as non–OSA/Lo CES-D subjects (35.3 vs. 18.3 min, $p = .012$) and OSA/Lo CES-D subjects (35.3 vs. 16.8 min, $p = .002$).

### Results

Table 3 shows values for demographic, sleep, and mood variables by Apnea/CES-D group. OSA subjects were slightly older (49.3 vs. 45.1 years, $p = .007$), so age was used as a covariate in subsequent analyses. As expected, OSA subjects were heavier (29.7 vs. 27.4 body mass index, $p = .004$), and had significantly greater RDI (50.7 vs. 5.6, $p < .001$) than non-OSA subjects. Also, subjects in the Hi CES-D group reported significantly more depressive symptoms than Lo CES-D subjects (25.0 vs. 6.2, $p < .001$). OSA and non-OSA subjects did not differ significantly on the CES-D (16.3 vs. 14.8, $p = .190$); and Hi and Lo CES-D subjects did not differ significantly in terms of RDI (25.8 vs. 29.0, $p = .509$).

In the MANCOVA, REM%, SWS%, and sleep latency were the dependent variables, and OSA (yes/no) and CES-D (Hi/Lo) were the independent variables. No significant main effects emerged for OSA (yes/no) for REML (109.6 vs. 109.8 min, $p = .991$), REM% (17.1% vs. 16.6%, $p = .784$), or SWS% (7.0% vs. 9.6%, $p = .148$). OSA and non-OSA/Lo CES-D subjects (35.3 vs. 18.3 min, $p = .012$) and OSA/Lo CES-D subjects (35.3 vs. 16.8 min, $p = .002$).

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<th>Table 3. Demographic Variables (Mean ± SD)</th>
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<td></td>
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$n = 106$. CES-D, Center for Epidemiological Studies—Depression; REM, rapid eye movement sleep; SWS, slow wave sleep (stages 3 + 4).

Significant main effect for OSA diagnosis.

Significant main effect for CES-D Hi/Lo interaction.

$p < .05$.

$p < .10$.
.010), and nearly three times as long as OSA/Hi CES-D subjects (35.3 vs. 12.1 min, \( p = .002 \)). Sleep latency differences between OSA/Lo CES-D and OSA/Hi CES-D and between OSA/Lo CES-D and non–OSA/Lo CES-D subjects were not significant.

Regarding the significant interaction for REM%, post-hoc analyses revealed that OSA/Hi CES-D subjects experienced higher REM% than OSA/Lo CES-D subjects (19.4% vs. 14.8%, \( p = .021 \)); however, non-OSA subjects did not differ in terms of REM% regardless of CES-D level; Hi CES-D subjects did not differ in terms of REM% regardless of apnea diagnosis; and Lo CES-D subjects did not differ in terms of REM% regardless of apnea diagnosis.

Data were also examined in stepwise regression analyses using continuous RDI and CES-D scores and the RDI × CES-D interaction. Age was controlled by forced entry. Using sleep latency as the dependent variable, only the interaction term entered the model (\( b = -4.462, \beta = -0.260, p = .008 \)). Using SWS% as the dependent variable, RDI (\( b = -0.001, \beta = -0.352, p < .001 \)) and CES-D (\( b = .002, \beta = .265, p = .004 \)) entered the model. Using REM% or REML as the dependent variables, none of the independent variables entered the model.

**Discussion**

It is well documented that mood disorders can have a detrimental effect on quality and quantity of sleep. Several researchers have observed sleep architecture differences between patients with varying levels of depressive symptoms. These differences have generally, but not always, included a cluster of abnormalities, such as shorter REML, increased REM%, diminished SWS%, and prolonged sleep latency; however, no single aspect of sleep architecture can be considered a definitive biological marker for depressive disorders.

OSA is a relatively common sleep disorder and patients with OSA often experience higher levels of depressive symptoms than people without a sleep disorder. Beyond such accepted markers as RDI, arousals, and oxygen desaturation, researchers have also documented longer REML, decreased REM%, diminished SWS%, and shorter sleep latency in OSA patients. As in the depression research, findings have not been consistent across studies for these variables.

Because depression and OSA have often been shown to have opposite effects on REML, REM%, and sleep latency, we were interested in examining how the depressive symptoms × OSA interaction would impact sleep architecture. Also, because of the burgeoning interest in the impact of subclinical levels of depressive symptoms on health and behavior, we wondered if these sleep architecture differences would hold when comparing subjects reporting a range of depressive symptoms—regardless of the presence of a diagnosed mood disorder. We hypothesized that OSA may confound sleep architecture observations when comparing groups of subjects with comparatively high and low levels of depressive symptoms. Conversely, we also hypothesized that high levels of depressive symptoms may confound sleep architecture differences found when comparing subjects with and without OSA.

In our sample of 106 subjects, we were able to replicate some of the findings from the sleep-in-depression literature as well as the sleep-in-OSA literature. Our OSA subjects experienced significantly shorter sleep latency—about half as long as that in subjects without OSA. There was also a trend for subjects who reported high levels of depressive symptoms to experience sleep latency one third longer than subjects reporting low levels of depressive symptoms. We did not observe significant differences between OSA and non-OSA subjects nor between Hi CES-D and Lo CES-D subjects for REML, REM%, or SWS%; however, the interaction of depressive symptoms and OSA diagnosis produced results that were statistically and clinically significant.

We had speculated that the REML-reducing effects of depression and the REML-increasing effects of OSA might offset each other in OSA patients who had depressive symptoms. Reynolds et al (1982, 1984) have reported REML findings that differ from our results. In that study, the REML in patients with OSA and depression was significantly longer than in patients having only OSA. They postulated that the association between the REM sleep abnormalities of depression and OSA might be due to the fact that both disorders increase with age. Our larger sample size allowed us to test the depression × OSA interaction and to control for the effects of age. These factors, along with the use of different scales for rating depression, may help explain our divergent findings.
Depressive symptoms and OSA diagnosis interacted to produce SL and REM% patterns that were not consistent with previously reported findings. Non-OSA subjects who endorsed high levels of depressive symptoms experienced the longest sleep latency—two to three times as long as all other subjects. Apparently, in non-OSA subjects, the presence of high levels of depressive symptoms significantly prolongs sleep latency. In OSA subjects, however, sleep latency seems to be resistant to the effects of depressive symptoms—remaining comparatively low regardless of the level of depressive symptoms reported. In OSA subjects reporting high levels of depressive symptoms, the fatigue associated with OSA may override the longer sleep latency that often accompanies high levels of depressive symptoms.

Regarding REM%, OSA subjects reporting high levels of depressive symptoms experienced REM% nearly one third higher than those OSA subjects with low levels of depressive symptoms. Thus, the presence of comparatively high levels of depressive symptoms may override the diminution of REM sleep often associated with OSA. In subjects without OSA, however, REM% did not differ in terms of level of depressive symptoms.

We did not find significant main effects or interaction effects with REML as the dependent variable. Some readers may ask about first-night effects, particularly in terms of REM sleep variables. Although this may have had an impact on our data, it is typical of the studies reported in our review to rely on single-night recordings.

We wondered if subjects in our sample might have experienced only minor depression rather than more serious levels of dysphoric mood and, if so, if this might help explain our results. To test this hypothesis, we increased the CES-D cutoff to 20; however, this change in cutoff did not significantly affect the findings reported here.

Our findings suggest that the presence of comparatively high levels of depressive symptoms—not simply the presence or absence of a diagnosed clinical mood disorder—must be considered in studies of sleep architecture in OSA patients. Conversely, the presence of OSA must be considered in studies of sleep architecture in subjects with mood disorders or with high levels of depressive symptoms. The interaction effects we observed may account for some of the differences in findings reported separately in previous studies of sleep architecture in depressed patients and OSA patients.

Limitations

There are certain limitations of this study that could impact the generalizability of our findings. Regarding potential bias in recruitment, we sought both subjects with and without symptoms suggestive of sleep apnea. It is possible that persons with particularly prominent apnea symptoms were more likely to seek inclusion in the study, thus skewing our sample toward those with more severe illness; however, the RDI in our participants ranged from 0 to 152, averaging 50 in the apneic group.

Some of our findings varied depending on the statistical methodology employed. Using sleep latency as the dependent variable, our findings regarding the RDI × CES-D interaction were consistent when using either dichotomous or continuous forms of this independent variable. Our findings regarding REM% could not be duplicated, however, when using continuous independent variables. Replication in another data set is required.

It is possible that the fatigue/sleepiness experienced by OSA patients confounded our evaluation of mood symptoms. As mentioned previously, the CES-D tends to assess cognitive/affective domains of depression and has been used successfully in other chronically ill groups experiencing fatigue. Nevertheless, we examined the relationship between CES-D and Epworth Sleepiness Scale (Johns 1991) scores in our OSA subjects. Results were not significant, suggesting that CES-D scores are not confounded by sleepiness/fatigue.

This work was supported by National Institutes of Health Grants Nos. HL44915, AG02711, and RR00827.

References


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