Obstructive Sleep Apnea Among Patients With Retinal Vein Occlusion

Agnès Glacet-Bernard, MD; Guillaume Leroux les Jardins, MD; Stéphane Lasry, MD; Gabriel Coscas, PhD; Gisèle Soubrane, PhD; Eric Souied, PhD; Bruno Housset, PhD

Objective: To evaluate the possible involvement of obstructive sleep apnea (OSA) in retinal vein occlusion (RVO).

Methods: From the medical records of 63 consecutive patients with RVO, 30 patients with 2 of the 3 following risk factors for OSA were selected for further screening from February 1, 2008, through March 31, 2009: associated cardiovascular disease, snoring, or daytime sleepiness.

Results: Of the 30 selected patients, 23 (77%) had OSA. If all 33 of the unscreened patients did not have OSA, the OSA prevalence would have been 37%. Among the patients with OSA, the mean apnea-hypopnea index (AHI) was 21; OSA was mild (AHI < 15) in 13 patients, moderate in 5 patients (AHI 15-30), and severe (AHI > 30) in 5 patients. The AHI was correlated with body mass index (P = .02).

Conclusions: We found a higher than expected prevalence of OSA in a series of patients with RVO. Our findings suggest that OSA could be an additional risk factor that plays an important role in the pathogenesis of RVO or at least that it is a frequently associated condition that could be a triggering factor. This association may explain why most patients discover visual loss on awakening. It is too early to assess whether OSA treatment could improve visual outcome of RVO, but it seems vital to recognize OSA in RVO for the general health of the patient.


Obstructive Sleep Apnea (OSA) is increasingly recognized as an important cause of medical morbidity and mortality.1-4 It is a relatively common condition characterized by repeated episodes of partial or complete obstruction of the superior airways, resulting in the cessation of breathing for 10 seconds or longer during sleep. The ensuing reduction of airflow often leads to trouble in exchange of gases in the lungs and recurrent incidences of arousal from sleep. It results in several abnormalities, such as activation of the sympathetic pathway, vascular endothelial dysfunction, increased oxidative stress, inflammation, increased platelet aggregability, and metabolic dysregulation, which could contribute to the initiation and progression of vascular diseases.3 Obstructive sleep apnea is insidious, and patients are often unaware of its symptoms, which include loud snoring, witnessed breathing pauses during sleep, fitful sleep quality, and excessive daytime sleepiness. There is, therefore, a widespread underrecognition of this disease.1-2 Early recognition and appropriate therapy can diminish the consequences of OSA and have favorable effects on cardiovascular health.6 There is no controversy, to our knowledge, regarding the need for better recognition and treatment of severe symptomatic OSA. The already known complications of OSA include hypertension, myocardial infarction, stroke, arrhythmia, and abnormal findings in glucose metabolism.2,6-9 Among ophthalmologic diseases, OSA has been suggested to be associated with glaucoma, nonarteritic anterior ischemic optic neuropathy, visual field defects, papilledema, and floppy eyelid syndrome.10-12 Recently, some of us13 published the cases of 3 patients with retinal vein occlusion (RVO) and OSA and discussed the possible relationship between these diseases. It is commonly known that most patients with RVO exhibit symptoms of visual loss on awakening, which alludes to the possibility that nocturnal events con-
Its pathogenesis remains not totally elucidated and results from multifactorial variables; it includes the slowdown of retinal circulation that aggravates the vicious circle of local hyperviscosity that can lead to the occlusion of the capillary bed.\textsuperscript{16-21} Vasculardisturbances observed during sleep in OSA could possibly correspond to a situation that predisposes patients to RVO. This study was therefore designed to estimate the prevalence of OSA among a series of patients with RVO.

METHODS

Among 63 consecutive patients with RVO, patients who had at least 2 of the following 3 risk factors for OSA were retrospectively selected for OSA screening: cardiovascular disease (hypertension, angina, or stroke), snoring, and daytime sleepiness with an Epworth Sleepiness Scale score of higher than 10. The 30 selected patients were evaluated for OSA in the Department of Pneumology, Intercommunal Hospital of Creteil, from February 1, 2008, through March 31, 2009. This study adhered to the tenets of the Declaration of Helsinki and was approved by the local institutional review board. Informed consent from each participant was obtained before screening.

Screened patients underwent respiratory polygraphy (CID 102 polygraph; Cidelec, Sainte-Gemmes-sur-Loire, France) via the following channels: tracheal sounds by a microphone taped on the neck, nasal flow by a cannula linked to a pressure transducer, oxygen saturation by digital oximetry, heart rate through the pulse oximetry signal, thoracic and abdominal movements by piezoelectric sensors, and body position by a mercury sensor and accelerometer. This examination was performed during an overnight stay in the hospital, and a sleep disorder specialist (S.L.) analyzed the results.

Apnea was defined as the complete cessation of breathing for at least 10 seconds. Hypopnea was defined as a reduction of nasal airflow alone to at least 50% of the value prevailing during preceding normal breathing or as a reduction of airflow less than 50% followed by a decrease in oxyhemoglobin saturation of more than 3% (and/or respiratory arousal with polysomnography) for at least 10 seconds. Sleep apnea severity is assessed by the apnea-hypopnea index (AHI), which measures the number of apneic and hypopneic events per hour. If the AHI is less than 15, OSA is considered mild; it is considered moderate if the AHI is 15 to 30 and severe when the AHI is greater than 30. The respiratory polygraphy also gives other data, including mean oxygen saturation level and duration with oxygen saturation less than 90%.

Ophthalmologic evaluation included best corrected visual acuity, slitlamp examination with tonometry, and fundus examination. The diagnosis of RVO was confirmed using fluorescein angiography. Final evaluation was performed at least 6 months after the beginning of the RVO.

Statistical analysis was performed using SPSS statistical software, version 13.0 (SPSS, Inc, Chicago, Illinois) for Microsoft Windows (Microsoft Corporation, Redmond, Washington) to compare patients with and without OSA. Differences between the groups were calculated using the Fisher exact test for qualitative data and the nonparametric Mann-Whitney test for quantitative data.

RESULTS

In this series, 77% of patients with RVO (23 of 30) had OSA. The mean patient age was 56.3 years, and the mean follow-up was 15 months (range, 6-24 months). Patient characteristics are given in Table 1. Of the 30 patients selected for OSA screening, 23 had central RVO, 5 had branch RVO, and 2 had hemicentral RVO. Table 2 gives the characteristics of these subgroups. No statistically significant difference was found between these groups regarding the baseline characteristics and the result of OSA screening, but the small sample in each subgroup could hinder statistical analysis.

Only 1 patient with hypertension was previously diagnosed as having OSA (patient 7). A diagnosis of mild OSA had been detected by the cardiologist 1 year before the onset of RVO; this mild positional OSA was not treated. The screening for OSA in our series of patients with RVO detected 22 new cases of OSA (73% of the screened patients with RVO).

The comparison of groups with and without OSA is given in Table 3. In the group with OSA, the mean AHI was 21.3. The OSA was mild (AHI <15) in 13 patients, moderate (AHI 15-30) in 5 patients, and severe (AHI >30) in 5 patients. The number of apnea or hypopnea episodes per hour was correlated with the body mass index (calculated as weight in kilograms divided by height in meters squared) ($P = .001$), the mean saturation of blood in oxygen ($P = .004$), and the duration with oxygen saturation of 90% ($P < .001$). The presence of OSA was not correlated with the age of the patient at the beginning of the RVO, the Epworth Sleepiness Scale score, or the initial or final visual loss.

In this group of selected patients, no statistically significant difference was found between patients with and without OSA regarding baseline characteristics. This study did not find any relationship between the severity of OSA assessed by the AHI and the severity of RVO assessed by final visual acuity.

Because they had moderate or severe OSA, 10 patients had to be treated with nasal continuous positive airway pressure with a mask during sleep. Other than for 1 patient, the treatment occurred several weeks or months after the onset of the RVO, and it was impossible to assess whether the treatment could play a beneficial role in visual outcome. The patient (patient 3) who underwent OSA treatment within the first month of the branch RVO experienced a notable improvement in visual acuity and a resolution of his daytime sleepiness.

COMMENT

The prevalence of OSA is approximately 2% to 7% in the general population.\textsuperscript{1,2} Although this series screened only a selected subset of a series of patients with RVO, if the nonselected patients are assumed to have no OSA, the estimated prevalence in a series of patients with RVO would be 37%. This lower estimate remains higher than what would be expected in the general population.

In this series, the patients were examined using respiratory polygraphy testing during an overnight stay in the hospital. The polysomnogram, which is considered the criterion standard for OSA diagnosis, was not used; the electroencephalographic data are therefore lacking, which could lead to underrecognition of OSA cases.
Our estimation of the prevalence of OSA in the population with RVO is therefore likely to be lower than the true value.

Obstructive sleep apnea is known to be more prevalent in different population subsets that correspond grossly to the profile of RVO patients, including older individuals, men, and overweight or obese people. Data from the community-based Sleep Heart Health Study have shown that disease prevalence increases steadily with age and reaches a plateau after the age of 60 years.22 In a probability sample from 2 Pennsylvania counties, OSA prevalence was shown to progressively increase with age.23 In men, OSA (AHI ≥10) was present in 3.2% of the 20- to 44-year age group, 11.3% of the 45- to 64-year age group, and 18.1% of the 65- to 100-year group. In a separate analysis of women from the same cohort, the prevalence of OSA in the same age groups was 0.6%, 2.0%, and 7.0%, respectively. Disease prevalence was lowest in premenopausal women (approximately 0.6%), intermediate in postmenopausal women receiving hormone therapy (approximately 1.1%), and relatively high in postmenopausal women not receiving hormone therapy (approximately 5.5%). In the current study, the mean age of patients was 56.3 years, and patients were mostly men, which corresponds to an expected prevalence of 11.0%. Even the lowest estimate of OSA prevalence of 37.0% in our series represents a more than 3-fold increase compared with a population of similar age. In this study, the 3 women identified as having OSA were not receiving hormone therapy. The sample was too small to give conclusions, but it is interesting to notice that previous studies24-28 have reported a lower prevalence of RVO in postmenopausal women receiving hormone therapy and that this category of women is likely to have less OSA.

### Table 1. Characteristics of the Patients With Obstructive Sleep Apnea

<table>
<thead>
<tr>
<th>Patient No./Sex/Age, y</th>
<th>BMI</th>
<th>Risk Factors</th>
<th>RVO Subtype</th>
<th>Final Visual Acuity</th>
<th>Snoring/Sleep Disturbances</th>
<th>Epworth Sleepiness Scale Score</th>
<th>AHI</th>
<th>Mean SpO2/Minimum SpO2/Time/H1102190% SpO2 Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/M/50</td>
<td>40</td>
<td>Hypertension</td>
<td>CRVO</td>
<td>20/125</td>
<td>Y/Y/Y</td>
<td>14</td>
<td>74</td>
<td>91/60/39 Treated</td>
</tr>
<tr>
<td>2/M/36</td>
<td>29</td>
<td>Hypertension</td>
<td>CRVO</td>
<td>20/40</td>
<td>Y/N/Y</td>
<td>9</td>
<td>51</td>
<td>94/79/4 Decision to treat</td>
</tr>
<tr>
<td>3/M/78</td>
<td>27</td>
<td>Hypertension</td>
<td>CRVO</td>
<td>20/20</td>
<td>Y/N/Y</td>
<td>8</td>
<td>43</td>
<td>94/75/16 Treated</td>
</tr>
<tr>
<td>4/M/61</td>
<td>28</td>
<td>Hypertension and cardiovascular history</td>
<td>CRVO</td>
<td>20/100</td>
<td>Y/N/Y</td>
<td>22</td>
<td>33</td>
<td>92/75/16 Treated</td>
</tr>
<tr>
<td>5/M/46</td>
<td>31</td>
<td>Hypertension, diabetes, and glaucoma</td>
<td>CRVO</td>
<td>20/32</td>
<td>Y/N/Y</td>
<td>6</td>
<td>32</td>
<td>96/77/1 Decision to treat</td>
</tr>
<tr>
<td>6/M/74</td>
<td>25</td>
<td>Hypertension and cardiovascular history</td>
<td>CRVO</td>
<td>12/320</td>
<td>Y/N/Y</td>
<td>19</td>
<td>28</td>
<td>92/80/10 Treated</td>
</tr>
<tr>
<td>7/M/68</td>
<td>22</td>
<td>Cardiovascular history</td>
<td>CRVO</td>
<td>20/100</td>
<td>N/N/N</td>
<td>10</td>
<td>24</td>
<td>94/91/0 Diagnosis before RVO, positional treatment</td>
</tr>
<tr>
<td>8/M/63</td>
<td>25</td>
<td>Hypertension and cardiovascular history</td>
<td>CRVO</td>
<td>20/20</td>
<td>Y/N/Y</td>
<td>10</td>
<td>24</td>
<td>94/67/5 Decision to treat</td>
</tr>
<tr>
<td>9/F/67</td>
<td>22</td>
<td>Hypertension and cardiovascular history</td>
<td>CRVO</td>
<td>20/40</td>
<td>Y/N/N</td>
<td>6</td>
<td>22</td>
<td>92/76/7 Treated</td>
</tr>
<tr>
<td>10/F/64</td>
<td>23</td>
<td>Hypertension</td>
<td>CRVO</td>
<td>20/63</td>
<td>Y/N/Y</td>
<td>11</td>
<td>22</td>
<td>94/75/0 Treated</td>
</tr>
<tr>
<td>11/M/59</td>
<td>43</td>
<td>Diabetes</td>
<td>BRVO</td>
<td>20/200</td>
<td>Y/Y/N</td>
<td>10</td>
<td>15</td>
<td>95/70/5 Not yet treated</td>
</tr>
<tr>
<td>12/M/47</td>
<td>26</td>
<td>Hypertension and cardiovascular history</td>
<td>CRVO</td>
<td>20/63</td>
<td>Y/N/N</td>
<td>2</td>
<td>14</td>
<td>95/77/0 Not yet treated</td>
</tr>
<tr>
<td>13/M/57</td>
<td>30</td>
<td>Hypertension</td>
<td>BRVO</td>
<td>20/400</td>
<td>Y/N/Y</td>
<td>11</td>
<td>14</td>
<td>94/81/3 Not yet treated</td>
</tr>
<tr>
<td>14/M/59</td>
<td>25</td>
<td>Glaucoma</td>
<td>CRVO</td>
<td>20/400</td>
<td>Y/N/Y</td>
<td>4</td>
<td>12</td>
<td>94/83/0 Not yet treated</td>
</tr>
<tr>
<td>15/M/40</td>
<td>25</td>
<td>Hypertension</td>
<td>CRVO</td>
<td>20/25</td>
<td>Y/Y/Y</td>
<td>18</td>
<td>12</td>
<td>94/83/1 Not yet treated</td>
</tr>
<tr>
<td>16/M/68</td>
<td>23</td>
<td>Hypertension, glaucoma, and cardiovascular history</td>
<td>BRVO</td>
<td>20/40</td>
<td>Y/N/N</td>
<td>0</td>
<td>11</td>
<td>96/88/0 Not yet treated</td>
</tr>
<tr>
<td>17/M/46</td>
<td>29</td>
<td>None</td>
<td>BRVO</td>
<td>20/25</td>
<td>Y/N/Y</td>
<td>12</td>
<td>10</td>
<td>94/86/1 Not yet treated</td>
</tr>
<tr>
<td>18/M/51</td>
<td>23</td>
<td>Hypertension and glaucoma</td>
<td>CRVO</td>
<td>20/200</td>
<td>Y/N/Y</td>
<td>15</td>
<td>10</td>
<td>96/74/2 Not yet treated</td>
</tr>
<tr>
<td>19/M/62</td>
<td>30</td>
<td>Diabetes and glaucoma</td>
<td>HCRVO</td>
<td>20/40</td>
<td>Y/Y/Y</td>
<td>2</td>
<td>9</td>
<td>94/87/0 Not yet treated</td>
</tr>
<tr>
<td>20/F/36</td>
<td>25</td>
<td>Hypertension</td>
<td>CRVO</td>
<td>20/100</td>
<td>Y/N/Y</td>
<td>14</td>
<td>9</td>
<td>96/72/1 Not yet treated</td>
</tr>
<tr>
<td>21/M/66</td>
<td>25</td>
<td>Hypertension</td>
<td>CRVO</td>
<td>20/32</td>
<td>Y/Y/N</td>
<td>4</td>
<td>7</td>
<td>96/89/0 Not yet treated</td>
</tr>
<tr>
<td>22/M/41</td>
<td>31</td>
<td>Hypertension</td>
<td>CRVO</td>
<td>20/100</td>
<td>Y/Y/Y</td>
<td>5</td>
<td>7</td>
<td>95/88/0 Not yet treated</td>
</tr>
<tr>
<td>23/M/56</td>
<td>23</td>
<td>Hypertension and glaucoma</td>
<td>CRVO</td>
<td>20/40</td>
<td>Y/N/Y</td>
<td>12</td>
<td>7</td>
<td>94/87/0 Not yet treated</td>
</tr>
</tbody>
</table>

Abbreviations: AHI, apnea-hypopnea index; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); BRVO, branch retinal vein occlusion; CRVO, central retinal vein occlusion; HCRVO, hemicentral retinal vein occlusion; RVO, retinal vein occlusion; SpO2, oxygen saturation as measured by pulse oximetry.
the current study, the AHI was correlated with the body mass index, which corroborates the known correlation between excess body weight and OSA with an estimated 58% of the moderate to severe cases attributable to a body mass index greater than or equal to 25.28

As reported in the literature,29 this condition is frequent but underrecognized, and it has been estimated that 80% to 95% of patients have undiagnosed OSA. Among our 23 patients with OSA, only 1 had a previous diagnosis of OSA; the remaining 22 patients were first recognized as having OSA after the occurrence of the RVO as part of this study. Given the high prevalence and public health burden of OSA, the implications of untreated disease for the individual and society are enormous and cannot be ignored.3 There is no controversy, to our knowledge, regarding the need for better recognition and treatment of OSA.1

Among ocular diseases already reported to be associated with OSA, nonarteritic anterior ischemic optic neuropathy probably shares the most common features with RVO.10 As in RVO, visual loss is disclosed on awakening, and associated risk factors include hypertension, diabetes mellitus, and arteriosclerosis. Moreover, Levin and Danesh-Meyer25 hypothesize that this disease may occur because of the obliteration of tributary venules that receive blood from optic nerve capillaries and drain into the central retinal vein, in contrast to RVO, in which the venous obliteration may occur anteriorly in the optic nerve head and cannot receive contribution from collateral venous drainage pathways from the retina.30,32 Mojon et al examined 17 patients with nonarteritic anterior ischemic optic neuropathy and 17 control individuals matched for age and sex, using polysomnography testing to assess diagnosis of OSA. They found that 71% of patients with nonarteritic anterior ischemic optic neuropathy had OSA, compared with 18% of controls. These figures seem similar to those observed in our series.

The local and systemic effects of OSA could explain, in some patients, the occurrence and/or the aggravation of RVO. Hemodynamic changes from sleep apnea may contribute to a cascade of events leading to RVO. These events may directly affect the retinal microcirculation, or they can act in concert with other predisposing conditions to RVO. The immediate physiologic effects of OSA involve nocturnal hypoxemia, hypercapnia, and inspiratory efforts. According to the seminal work of Hayreh,31 the venous drainage of the retina and of the optic

### Table 2. Comparison Between Patients With CRVO and Those With BRVO and HCRVO

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>CRVO (n=23)</th>
<th>BRVO and HCRVO (n=7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male sex, No. (%)</td>
<td>19 (83)</td>
<td>7 (100)</td>
</tr>
<tr>
<td>Mean (SD) age, y</td>
<td>56.3 (11.9)</td>
<td>61.0 (4.6)</td>
</tr>
<tr>
<td>Body mass index&lt;sup&gt;a&lt;/sup&gt;</td>
<td>26.1 (10)</td>
<td>30.6 (6.1)</td>
</tr>
<tr>
<td>Hypertension, No. (%)</td>
<td>16 (70)</td>
<td>5 (71)</td>
</tr>
<tr>
<td>Diabetes mellitus, No. (%)</td>
<td>3 (13)</td>
<td>3 (43)</td>
</tr>
<tr>
<td>Glaucoma, No. (%)</td>
<td>6 (26)</td>
<td>2 (29)</td>
</tr>
<tr>
<td>Epworth Sleepiness Scale score</td>
<td>9.8 (6)</td>
<td>6.7 (4.6)</td>
</tr>
<tr>
<td>Associated sleep apnea syndrome, No. (%)</td>
<td>17 (74)</td>
<td>6 (86)</td>
</tr>
<tr>
<td>Apnea-hypopnea index</td>
<td>19.1 (18.3)</td>
<td>10 (3.8)</td>
</tr>
</tbody>
</table>

Abbreviations: BRVO, branch retinal vein occlusion; CRVO, central retinal vein occlusion; HCRVO, hemiretinal central vein occlusion.

### Table 3. Comparison Between Patients With Retinal Vein Occlusion With and Without OSA and Nontested Patients

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Patients With OSA (n=23)</th>
<th>Patients Without OSA (n=7)</th>
<th>Nontested Patients&lt;sup&gt;b&lt;/sup&gt; (n=33)</th>
<th>Difference Between Patients With and Without OSA</th>
<th>Difference Between Tested and Nontested Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male, No. (%)</td>
<td>20 (87)</td>
<td>6 (86)</td>
<td>20 (61)</td>
<td>.67</td>
<td>.02</td>
</tr>
<tr>
<td>Age, y, mean (SD)</td>
<td>56.3 (11.9)</td>
<td>61.0 (4.6)</td>
<td>65.3 (12.5)</td>
<td>.13</td>
<td>.01</td>
</tr>
<tr>
<td>Body mass index&lt;sup&gt;a&lt;/sup&gt;</td>
<td>27.4 (5.3)</td>
<td>26.4 (2.6)</td>
<td>24.4 (2.8)</td>
<td>.65</td>
<td>.006</td>
</tr>
<tr>
<td>Hypertension, No. (%)</td>
<td>17 (74)</td>
<td>4 (58)</td>
<td>13 (40)</td>
<td>.34</td>
<td>.02</td>
</tr>
<tr>
<td>Diabetes mellitus, No. (%)</td>
<td>4 (17)</td>
<td>2 (28)</td>
<td>4 (12)</td>
<td>.30</td>
<td>.20</td>
</tr>
<tr>
<td>Glaucoma, No. (%)</td>
<td>6 (26)</td>
<td>2 (28)</td>
<td>5 (16)</td>
<td>.53</td>
<td>.65</td>
</tr>
<tr>
<td>Epworth Sleepiness Scale score</td>
<td>9.7 (5.7)</td>
<td>7.1 (4.0)</td>
<td>5.2 (3.6)</td>
<td>.27</td>
<td>.001</td>
</tr>
<tr>
<td>Snoring, No. (%)</td>
<td>22 (96)</td>
<td>7 (100)</td>
<td>19 (65)</td>
<td>.77</td>
<td>.001</td>
</tr>
<tr>
<td>Sleep disturbance, No. (%)</td>
<td>16 (70)</td>
<td>3 (43)</td>
<td>3 (9)</td>
<td>.66</td>
<td>.05</td>
</tr>
<tr>
<td>AHI</td>
<td>21.3 (16.6)</td>
<td>2.7 (1.9)</td>
<td>NA</td>
<td>NA .001</td>
<td>NA</td>
</tr>
<tr>
<td>Mild OSA (AHI &lt;15), No. (%)</td>
<td>13 (56)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Moderate OSA (AHI 15-30), No. (%)</td>
<td>5 (22)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Severe OSA (AHI &gt;30), No. (%)</td>
<td>5 (22)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Blood oxygen saturation, mean (SD), %</td>
<td>94.1 (1.4)</td>
<td>94.3 (1.1)</td>
<td>NA</td>
<td>.83</td>
<td>NA</td>
</tr>
<tr>
<td>Minimum blood oxygen saturation, mean (SD), %</td>
<td>79 (7.8)</td>
<td>85 (4.1)</td>
<td>NA</td>
<td>.02</td>
<td>NA</td>
</tr>
<tr>
<td>Time with blood oxygen saturation &lt;90%, mean (SD), %</td>
<td>6.3 (12.9)</td>
<td>0.14 (0.4)</td>
<td>NA</td>
<td>.03</td>
<td>NA</td>
</tr>
<tr>
<td>Central retinal vein occlusion, No. (%)</td>
<td>18 (76)</td>
<td>7 (100)</td>
<td>NA</td>
<td>.82</td>
<td>NA</td>
</tr>
<tr>
<td>Final visual acuity</td>
<td>20/80</td>
<td>20/125</td>
<td>NA</td>
<td>.52</td>
<td>NA</td>
</tr>
</tbody>
</table>

Abbreviations: AHI, apnea-hypopnea index; NA, not applicable; OSA, obstructive sleep apnea.

<sup>a</sup>Patients who did not meet the criteria for OSA screening (ie, at least 2 of the 3 following conditions: cardiovascular disease [hypertension, angina, or stroke] snoring, and/or Epworth Sleepiness Scale score of ≥10).

<sup>b</sup>Calculated as weight in kilograms divided by height in meters squared.
nerve head happens via the central retinal vein, which shares an adventitial sheath with the central retinal artery. Hypoxia-induced vasodilation of the central retinal artery can compress the central retinal vein and its tributaries within their shared sheath. Hypercapnia-induced cerebral vasodilation leads to an increase in intracranial pressure and sometimes ultimately to increased cerebral spinal fluid pressure, resulting in papilledema and elevated venous pressure in the optic nerve head. All these situations may induce a slowdown of blood flow circulation in the retina and the optic nerve. The slowdown of retinal circulation has been suggested in the pathogenesis of RVO by initiating a vicious circle in which hyperviscosity plays an important role. Elevated venous pressure resulting from the slowdown of blood circulation increases the passage of the plasmatic component of blood through the vessel wall, leading to hematocrit concentration and local hyperviscosity. The latter is also increased by the erythrocyte aggregation phenomenon promoted by a local increase in hematocrit and fibrinogen level. This double vicious circle described by Stolz is reversible if blood flow is reestablished but can conversely lead to severe stasis and occlusion of the capillary bed. Large fluctuations in vascular oxygen and carbon dioxide function as metabolic stresses that may overwhelm the autoregulatory capacity of the optic nerve head and the retina. Inspiratory efforts against occluded passageways often lead to incidences of arousal from sleep that activate the sympathetic nervous system and create sleep disturbance. These incidences cause short-term increases of arterial blood pressure that can lead to brutal hemodynamic disturbances. It is possible that repetitive hemodynamic changes in the central retinal artery secondary to sleep disturbance can contribute to an occlusion of the fellow dilated vein (in the same adventitial sheath), in which the blood flow is already slower. Moreover, alterations in vascular functioning can impair the autoregulatory capacity of retinal vessels, leaving them vulnerable to ischemic events.

Additional effects secondary to sleep fragmentation and deprivation are increased sympathetic activation, oxidative stress, vascular endothelial dysfunction, increased platelet aggregability, inflammation, and metabolic dysregulation. All of these can also be incriminated in the development of the hypercoagulable state and the promotion of RVO.

CONCLUSION

This evaluation of 30 patients selected from a series of 63 with RVO suggests a strong association between RVO and OSA. Limitations of the study include the use of historical controls for comparison and evaluation of OSA in only a subset of patients with RVO at increased risk for OSA. A causal relationship cannot be concluded on the basis of the current study, and further studies are needed to determine the exact prevalence of OSA in the population with RVO. This study suggests that OSA, by acting on retinal microcirculation, could be an added risk factor for the occurrence of RVO or, at least in older patients with a vascular profile, an associated condition that could play a determinant role in the development of RVO and that could act as a triggering factor.

It is too early to know whether OSA treatment could modify the course of RVO or at least prevent its recurrence or the involvement of the second eye. Nevertheless, in clinical practice, it seems vital for the physician to be aware of this association because OSA treatment has demonstrated its efficacy in reducing the risk of cardiovascular and cerebrovascular disease in virtually any patient.

Submitted for Publication: December 9, 2009; final revision received February 24, 2010; accepted April 5, 2010.

Correspondence: Agnès Glacet-Bernard, MD, Department of Ophthalmology, Centre Hospitalier Intercommunal (Assistance Publique des Hôpitaux de Paris), 40 av de Verdun, 94000 Creteil, France (agnes.glacet@chcretel.fr).

Author Contributions: Drs Glacet-Bernard, Leroux les Jardins, and Lasry had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Financial Disclosure: None reported.

REFERENCES


