The Influence of Sleep Disordered Breathing on Cardiovascular Function

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An Obstructive Event in a 37y/o 148lb Male
Apnea in a 27y/o 5’5” 320lb Male
Normal Oxygenation with Increased Respiratory Disturbance
Normal Oxygenation w/Increased Apneas & Arousals
The longest continuous time with saturation <89 was 00:02:32, which started at 01:53:16.

A desaturation event was defined as a decrease of saturation by 4 or more.
2 events were excluded due to artifact.
There were 3 desaturation events over 3 minutes duration.

There were 553 desaturation events of less than 3 minutes duration during which:
The mean high was 92.8%. The mean low was 84.9%.
The mean length of events that were >10 sec x <3 mins was: 38.7 sec.
Desaturation event index (number of events per hour): 48.8
Effects of Age on OSA

Figure 1. Prevalence of OSA by age in the Sleep Heart Health Study (31). SDB = Sleep-disturbed breathing.
In a 2000 study (JAMA), it was found that as little as 10% weight gain resulted in a 6 fold increase in the risk of moderate to severe Obstructive Sleep Apnea.
Weight Loss Associated with Reduction in AHI

Figure 3. Estimated mean AHI reduction (as a percentage of baseline AHI) associated with mean weight loss (as a percentage of baseline weight) from clinical studies of dietary weight loss (triangles), surgical weight loss (circles), and one population-based observational study of weight change (fitted regression line). Note that the regression line is fitted to individual observations from Peppard and coworkers (210) and is not fitted to the points (representing other studies) in the figure. Letters indicate the following references: a (207), b (200), c (201), d (275), e (208), f (209), g (202), h (202), i (203), j (197), k (196), l (205).
Effects of OSA on Sympathetic Outflow

Figure 73-5. Recording of muscle sympathetic nerve activity (A) from a normal volunteer and (B) from a patient with obstructive sleep apnea before therapy; shown is the high resting sympathetic tone in the patient compared with the normal subject. Recordings are made using microneurography from the peroneal nerve. Subjects were supine, quietly awake. In both subjects, the resting oxygen saturation was more than 96%.
Physiological Consequences of SDB

- Plunging blood oxygen saturation
- Negative swings in intra-thoracic pressure
- Increase in blood pressure
- Surge in sympathetic nerve activity

Morgan et al. Sleep 1996
Schematic of CV Dysfunction in OSA
Effects of Nocturnal Oxygenation on PA Pressure in COPD Patients

Peacock, et al Thorax 02
Effects of Nocturnal Oxygenation on PA pressure in COPD Patients

Peacock, et al Thorax 02
Pulmonary Hemodynamics in the OSA Syndrome

- 220 patients with AHI>20
- Right heart catheterization
- Pulmonary hypertension defined as mean PAP >20mmHg
- 37/220 (17%)

Krieger et al, Chest 96
Cardiovascular disease present in 37% of cases with sleep apnea, compared to 7% of subjects without sleep apnea.

- "efficient treatment of OSA reduces the excess CVD risk and may be considered also in relatively mild OSA without regard to daytime sleepiness" – Am J Resp & Crit Care Med, 7/15/02.
Table 3. Trend Analysis for the Relationship between Increased Severity of the Obstructive Sleep Apnea Syndrome and the Composite Outcome of Stroke or Death from Any Cause (N=1022).*

<table>
<thead>
<tr>
<th>Severity of Syndrome</th>
<th>Stroke or Death</th>
<th>Mean Follow-up Period</th>
<th>Hazard Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Events</td>
<td>No. of Patients</td>
<td>yr</td>
</tr>
<tr>
<td>AHI ≤3 (reference score)</td>
<td>13</td>
<td>271</td>
<td>3.08</td>
</tr>
<tr>
<td>AHI 4–12</td>
<td>21</td>
<td>258</td>
<td>3.06</td>
</tr>
<tr>
<td>AHI 13–36</td>
<td>20</td>
<td>243</td>
<td>3.09</td>
</tr>
<tr>
<td>AHI &gt;36</td>
<td>34</td>
<td>250</td>
<td>2.78</td>
</tr>
</tbody>
</table>

* P=0.005 by the chi-square test for linear trend. AHI denotes apnea–hypopnea index, and CI confidence interval.
Results from the Sleep Heart Health Study: Gottlieb, et al Circulation, 2010

- 1927 men and 2495 women free of CHD, >40y/o participated and followed for a median of 8.7 years.
- OSA was an independent predictor of CHD in men <70y/o with a Hazard Ratio of 1.10 (HR of 1.68 with AHI>30/hr).
- 24% of men and 11% of women were defined as having moderately severe OSA on the baseline polysomnogram (AHI>15/hr). Of 3794, only 5.5% were given a Dx of OSA and only 2.1% reported any Tx for OSA.
- Of the 3794, there were 76 CHD deaths, 185 MI’s, and 212 revascularizations
- In men between the ages of 40 & 70, an AHI > 30/hr correlated with a 68% increased risk of developing CHD and 58% more likely to develop heart failure.
CPAP & OSA
24 Hour BP Before and After 1 Month of CPAP, Therapeutic Versus Sub-therapeutic
SDB in Ischemic Heart Disease: A comparison of post MI, unstable angina and stable angina

Figure 1  Respiratory events during sleep. Percentages indicate relative distribution of central, mixed, and obstructive events.
SDB in Ischemic Heart Disease: A comparison of post MI, unstable angina and stable angina

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total sleep time (min)</td>
<td>329 (33)</td>
<td>310 (68)</td>
<td>328 (33)</td>
</tr>
<tr>
<td>Sleep latency (min)</td>
<td>16.40 (11.27)</td>
<td>23.31 (14.54)</td>
<td>21.73 (16.04)</td>
</tr>
<tr>
<td>Sleep efficiency (%)</td>
<td>83.60 (7.22)</td>
<td>75.23 (17.44)</td>
<td>80.92 (10.05)</td>
</tr>
<tr>
<td>Arousal (n/h)</td>
<td>5.15 (3.71)*</td>
<td>5.31 (2.14)*</td>
<td>2.83 (1.51)</td>
</tr>
<tr>
<td>Light sleep (%)</td>
<td>71.22 (8.94)</td>
<td>72.08 (12.87)</td>
<td>67.14 (8.53)</td>
</tr>
<tr>
<td>Deep sleep (%)</td>
<td>12.45 (9.76)</td>
<td>12.10 (7.31)</td>
<td>14.23 (7.86)</td>
</tr>
<tr>
<td>REM sleep (%)</td>
<td>16.05 (7.12)</td>
<td>16.63 (7.96)</td>
<td>19.45 (7.42)</td>
</tr>
<tr>
<td>Sleep heart rate (beats/min)</td>
<td>57.93 (6.49)</td>
<td>57.11 (7.15)</td>
<td>54.24 (5.85)</td>
</tr>
<tr>
<td>AHI (n/h)</td>
<td>11.10 (19.42)†</td>
<td>14.79 (20.52)†</td>
<td>2.82 (6.43)</td>
</tr>
<tr>
<td>Mean apnoea duration (s)</td>
<td>17.64 (4.26)*</td>
<td>16.23 (3.63)</td>
<td>13.47 (4.73)</td>
</tr>
<tr>
<td>Longest apnoea (s)</td>
<td>31.56 (9.33)†</td>
<td>24.67 (10.85)*</td>
<td>16.95 (7.08)</td>
</tr>
<tr>
<td>Apnoea total time (min)</td>
<td>11.82 (12.27)†</td>
<td>8.55 (13.88)*</td>
<td>0.65 (0.56)</td>
</tr>
<tr>
<td>Mean Sao₂ (%)</td>
<td>96.23 (1.12)</td>
<td>96.42 (1.35)</td>
<td>97.03 (0.69)</td>
</tr>
<tr>
<td>Minimum Sao₂ (%)</td>
<td>90.10 (4.23)*</td>
<td>89.45 (5.24)*</td>
<td>93.42 (2.48)</td>
</tr>
<tr>
<td>Total time at Sao₂ &lt; 90% (min)</td>
<td>0.89 (2.40)*</td>
<td>1.42 (3.23)*</td>
<td>0.01 (0.05)</td>
</tr>
</tbody>
</table>

Values are mean (SD).
*p < 0.05 v group 3; †p < 0.01 v group 3.
AHI, apnoea-hypopnoea index; REM, rapid eye movement; Sao₂, arterial oxygen saturation.
Time course of relative changes in FVC

Time course of relative changes in distance walked in 6 min by the patients

Conclusions

- Sleep disordered breathing is an independent risk factor for coronary heart disease.
- OSA and nocturnal hypoxemia increase sympathetic outflow and create a chronic form of systemic inflammation.
- Early diagnosis and treatment for OSA are important factors of reducing the risk of coronary heart disease.
- CPAP compliance, diet and exercise remain the heart of reducing the influence of sleep disordered breathing on coronary heart disease.