Abdominal fat and Obstructive Sleep Apnea

Giora Pillar, MD, PhD
Sleep Clinic, Rambam Medical Center
Technion – Israel Institute of Technology
Haifa, ISRAEL

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Airway and normal air passage

Airway during snoring

Airway during apnea
Obstructive Apnea: A complete blockage of the airway despite efforts to breath. Notice the effort gradually increasing ending in airway opening.

Blood oxygen levels reduce to $\leq 3\%$ of baseline value.
<table>
<thead>
<tr>
<th>Severity</th>
<th>RDI</th>
<th>Min O2Sat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt;5</td>
<td>&gt;95</td>
</tr>
<tr>
<td>Mild</td>
<td>5-19</td>
<td>&gt;85</td>
</tr>
<tr>
<td>Moderate</td>
<td>20-39</td>
<td>&gt;65</td>
</tr>
<tr>
<td>Severe</td>
<td>&gt;40</td>
<td>&lt;65</td>
</tr>
</tbody>
</table>
Clinical Characteristics

• Loud Snoring
• Somnolence
  • Witnessed apneas
  • Dry mouth
  • Headaches
  • Nocturnal sweating, nocturia, enuresis
  • Sexual dysfunction
Consequences of EDS

- Motor vehicle crashes
- Work-related accidents
- Impaired school or work performance
- Social embarrassment
- Marital problems
- Memory and concentration difficulties
- Depression
- Impaired quality of life
Consequences of recurrent apneas with hypoxemia and sympathetic activation

- Systemic hypertension
- Pulmonary hypertension
- Ischemic heart disease, CHF
- Cardiac arrhythmias
- Polycythemia
- Stroke
- GER
- Impotence
Apnea patients
OSA

Obesity
Correlation between BMI and RDI

\[ R^2 = 0.2349 \]
Obesity and OSA


About 2/3 of OSA patients are overweight.

There is positive correlation between the degree of obesity and the severity of OSA.
Pathophysiology

- A combination of UAW narrowing (anatomical) and inability of UAW muscle to compromise (physiological).
Reduced airway size in obstructive sleep apnea  Comparison of an axial image at the minimum airway area (retropalatal region) of a normal subject (left) and a patient with sleep apnea (right). Note the smaller airway size and airway width in the patient with sleep apnea. In addition, the thickness of the lateral pharyngeal wall (distance between the airway and parapharyngeal fat pads) is larger in the patient with sleep apnea. Courtesy of Richard J Schwab, MD.
Reduced upper airway size in obstructive sleep apnea
Comparison of a mid-sagittal image of a normal subject (left) and a patient with sleep apnea (right). Soft palate and tongue area are larger in the patient with sleep apnea, leading to a reduction in upper airway size. Courtesy of Richard J Schwab, MD.
Figure 1: The balance of forces

Inspiratory negative pressure and extraluminal positive pressure tend to promote pharyngeal collapse. Upper airway dilator muscles and increased lung volume tend to maintain pharyngeal patency.
Pathogenesis of Pharyngeal Obstruction in OSA

INADEQUATE AIRWAY ANATOMY

AIRWAY RECEPTOR MECHANISMS
(-) pressure/collapse

UPPER AIRWAY PATENCY

C.N.S.

ACTIVITY OF PHARYNGEAL DILATORS
( Genioglossus )

Control of breathing

Sleep
( - )

wake

(+)

(-)

Sleep
( - )
Increased GGEMG in OSA
Increased GGEMG in OSA (awake)
Fig 1. The stunted chin gives the patient a typical bird-like face.
Obesity and OSA

Mechanism:
Nasopharyngeal anatomy
Nasopharyngeal physiology
Lung Mechanics
## Obesity and OSA - UAW MRI: Anatomy

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Controls</th>
<th>Non-Ob OSA</th>
<th>Obese OSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Age</td>
<td>38±3</td>
<td>40±4</td>
<td>40±3</td>
</tr>
<tr>
<td>BMI</td>
<td>25±1</td>
<td>26±1</td>
<td>34±1</td>
</tr>
<tr>
<td>NC</td>
<td>38±1</td>
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<td>44±1</td>
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<tr>
<td>AHI</td>
<td>-</td>
<td>33±6</td>
<td>42±6</td>
</tr>
<tr>
<td>Epworth</td>
<td>5±1</td>
<td>11±2</td>
<td>12±2</td>
</tr>
<tr>
<td>NTV</td>
<td>335</td>
<td>369</td>
<td>443</td>
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<tr>
<td>NFV</td>
<td>76</td>
<td>100</td>
<td>153</td>
</tr>
<tr>
<td>minUAW</td>
<td>47.3</td>
<td>21.8</td>
<td>12.8</td>
</tr>
</tbody>
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Douglas, AJRCCM 1998
Pathogenesis of Pharyngeal Obstruction in OSA

Inadequate Airway Anatomy

Upper Airway Receptor Mechanisms ((- pressure/ collapse)

Sleep ( - )

Fat deposit in UAW muscle limit their activation

Activity of Pharyngeal Dilators (Genioglossus) (+)

Sleep (-)

Fat deposit in UAW reduce its’ volume
Obesity and OSA
The effect of lung volume

• Direct relationship between lung volume and pharyngeal cross section area

• This lung volume dependent pharyngeal size is greater in OSA
  (greater reduction with expiration TLC→RV)

Bradley, NEJM 1986, Hoffstein, ARRD 1984
Figure 1: **The balance of forces**
Inspiratory negative pressure and extraluminal positive pressure tend to promote pharyngeal collapse. Upper airway dilator muscles and increased lung volume tend to maintain pharyngeal patency.
Obesity and OSA

Weight reduction is associated with improvement in OSA

Block, Chest 1982
Smith, Ann Int Med 1985
Browman, Chest 1985
Charuzi, Surgery 1985
Sugerman, Chest 1986
Suratt, Chest 1987
Rubinstein, ARRD 1988
Schwartz, ARRD 1991
Shelton, ARRD 1993
Conclusions

Obesity (central) is the most important risk factor for OSA, which is the most common cause of EDS.

Weight reduction results in substantial improvement up to total elimination of OSA.
Insulin resistance

Diabetes

Obesity

Cardiovascular sequelae

↑ Endothelin
↓ Vagus

Sympathetic activation

Arousal

Sleep fragmentation

↑ Activity of pharyngeal dilators (genioglossus)

Maintains upper airway patency

Sleep onset

Loss of negative pressure reflex

↓ Activity of pharyngeal dilators

Airway collapse

Hypoxia and hypercapnia

↑ Respiratory effort

Insufficient anatomy

Compensatory negative pressure reflex

Neurocognitive sequelae
Conclusions

OSA

Obesity