The Upper Airway and Sleep Disorders in Adults

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The Upper Airway and Sleep Disorders in Adults

- To understand and define the spectrum of sleep disordered breathing
- To review the pathogenesis and clinical presentation of obstructive sleep apnea
- To highlight the diagnostic algorithm in obstructive sleep apnea
- To discuss medical consequences of obstructive sleep apnea
Spectrum of Sleep Disordered Breathing

- Snoring
- UARS
- Hypopneas
- Obesity-Hypoventilation Syndrome
- Apneas
Snoring

- 25% of men and 15% of women are habitual snorers
  - Alcohol increases snoring

- Consequences:
  - 30 - 50% of asymptomatic snorers have sleep apnea
  - Upper airway resistance syndrome
  - Risk factor for HTN, CVA, MI ? carotid atherosclerosis
  - Socially unacceptable (marital conflicts, sleeping in the living room)
Upper Airway Resistance Syndrome

- Patients with crescendo snoring
- Excessive daytime sleepiness even without apneas/hypopneas
- Increase in upper airway resistance triggers arousal; hence sleep fragmentation
- Esophageal balloon to measure increased upper airway resistance for definitive diagnosis
- Treat with CPAP - determine an appropriate level which abolishes snoring
Upper Airway Resistance Syndrome
Does Snoring Lead to Carotid Atherosclerosis?

Producative Concept

Heavy snoring as a cause of carotid artery atherosclerosis.

Lee SA et al, Sleep 31:1207, 2008

- 110 volunteers (snorers and nonsnorers with only mild non-hypoxic OSA)
- 3 snoring groups: 1) mild (0-25% of the night), 2) moderate (> 25-50% of the night), 3) heavy (> 50% of the night)
Heavy Snoring (% of Night >50%) Increases Prevalence of Carotid Atherosclerosis but not Femoral (Lee SA, et al, Sleep 31:1207, 2008)

Prevalence of carotid atherosclerosis was 20% with mild snoring, 32% with moderate snoring and 64% with heavy snoring (p < 0.04)
**Risk Factors for Carotid Atherosclerosis**  
*(Lee SA, et al, Sleep 31:1207, 2008)*

Snoring group model for carotid atherosclerosis

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<th>Factor</th>
<th>OR</th>
<th>95% CI</th>
<th>P Value</th>
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<td>Age, per decade</td>
<td>3.2</td>
<td>1.4-7.2</td>
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<td>Male sex</td>
<td>4.6</td>
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<td>Positive smoking history</td>
<td>3.9</td>
<td>1.1-13.5</td>
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<td>Positive for hypertension</td>
<td>4.7</td>
<td>1.3-15.7</td>
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<td>Snoring, % of sleep time</td>
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<td>25 - 50</td>
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<td>0.4-6.9</td>
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<td>&gt; 50</td>
<td>10.5</td>
<td>2.1-51.8</td>
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Spectrum of Sleep Disordered Breathing

Snoring ↔ UARS ↔ Hypopneas

Obesity-Hypoventilation Syndrome ↔ Apneas
Obstructive Sleep Apnea Syndrome

- Obstructive sleep apnea a major public health problem affecting 2 - 4% (4 - 9%) middle-aged population

- Recurrent apneic episodes secondary to upper airway occlusion in presence of respiratory effort (chest wall and abdominal wall movement)
Presentation of Obstructive Sleep Apnea

- Middle aged overweight men and women
- Loud snoring*
- Excessive daytime sleepiness* (Epworth Sleepiness Scale)
- Witnessed apneas, nocturnal awakening
- Gasping or choking episodes during sleep
- Obesity*
- Retrognathia (recessed chin)*
Presentation of Obstructive Sleep Apnea

- Increased neck size (> 17 inches in a male; > 15 inches in a female)
- Crowded upper airway - increased tongue size
- Unrefreshing sleep, morning headaches
- Irritability, memory loss, personality change
- Nocturia, decreased libido
- Automobile or work related accidents
- Systemic hypertension
Physical Findings in Patients with Sleep Apnea

- Obesity
- Increased neck circumference
- Nasal airway restriction: septal deviation, allergic rhinitis, nasal polyps
- Macroglossia/tongue ridging
- Adeno-tonsillar hypertrophy (palatine/lingual tonsils)
- Lateral peritonsillar narrowing
- Enlargement/elongation of the soft palate
- Recessed mandible (retrognathia)/maxilla
- Narrowed hard palate - overbite/overjet
- Crowded upper airway - Mallampati score
Obesity Trends* Among U.S. Adults

CDC, 1991 - 2008

(*BMI > 30, or about 30 lbs overweight for 5’4” person)
Physical Examination and Sleep Apnea
(Schellenberg AJRCCM 162;740-748, 2000)

- Hypothesized that narrowing of airway by upper airway structures would be associated with an increased risk for obstructive apnea
- Prospectively studied cohort of 420 patients
- Association between individual variables in clinical model and sleep apnea were compared using odds-ratios (OR)
Morphometric Measurements
(Schellenberg AJRCCM 162;740-748, 2000)

- Macroglossia: tongue being above level of mandibular occlusal plane
- Uvula enlargement: > 1.5 cm in length or > 1.0 cm in width
- Enlargement of lateral walls: > 25% impingement pharyngeal space by peritonsillar tissues
- Tonsillar enlargement: > 50% lateral impingement of posterior pharyngeal airspace
Modified Mallampati Classification

- Tsai et al, AJRCCM 167,1427-1432, 2003
Normal Upper Airway
(Schellenberg et al, AJRCCM 162;740-748, 2000)
Macroglossia

Tongue ridging

Physical Examination and Sleep Apnea
(Schellenberg et al, AJRCCM 162;740-748, 2000)
Physical Examination and Sleep Apnea
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- Enlarged Uvula
- Lateral Narrowing
Physical Examination and Sleep Apnea
(Schellenberg et al, AJRCCM 162;740-748, 2000)
## Physical Examination and Sleep Apnea

(Schellenberg AJRCCM 162;740-748, 2000)

Adjusted Odds Ratio (OR) for Sleep Apnea

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<thead>
<tr>
<th>Physical Finding</th>
<th>OR</th>
<th>95% CI</th>
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<tr>
<td>Lateral Narrowing</td>
<td>2.6*</td>
<td>1.7 - 4.1</td>
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<td>Tonsillar hypertrophy</td>
<td>2.1*</td>
<td>1.1 - 4.2</td>
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<tr>
<td>Macroglossia</td>
<td>2.0</td>
<td>1.1 - 3.6</td>
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<tr>
<td>Enlarged soft palate</td>
<td>1.9</td>
<td>1.2 - 2.9</td>
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<tr>
<td>Retrognathia</td>
<td>1.3</td>
<td>0.8 - 2.1</td>
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</tbody>
</table>

*Maintained significance after adjusting for BMI/neck size
Sleep Disordered Breathing
Definitions

• Apnea: cessation of breathing for > 10 seconds
• Hypopnea: 50% decrement in airflow associated with a 4% drop in oxygen saturation and/or an arousal
• Apnea Hypopnea Index (AHI): number of apneas plus hypopneas/hour of sleep
Apnea Hypopnea Index (AHI)

- AHI 0 - 5 events/hour: Normal
- AHI 5 - 15 events/hour: Mild sleep apnea
- AHI 15 - 30 events/hour: Moderate sleep apnea
- AHI > 30 events/hour: Severe sleep apnea
Work-up of Obstructive Sleep Apnea

- Screening overnight oximetry (optional)
  - May be useful in a hospitalized patient
- Overnight polysomnography (gold standard)
  - First night diagnostic study
  - Second night therapeutic study with CPAP
- Split-night polysomnography - cost effective
- Home studies
Recurrent $O_2$ Desaturations in a Patient with Obstructive Sleep Apnea ($pCO_2$ no Change)
Sagittal Upper Airway MR Images

Normal Subject

Apneic Patient
Axial Upper Airway MR Images

Normal Subject  Apneic Patient
Patient with Sleep Apnea

Normal Subject

Tongue
Mandible
Parapharyngeal Fat Pads
Airway
Soft Palate
Pharyngeal Walls

Tongue
Mandible
Parapharyngeal Fat Pads
Airway
Soft Palate
Pharyngeal Walls

Schwab et al, AJRCCM 168; 522-530, 2003
### Volumetric Anatomic Risk Factors for Sleep Apnea

*(Cases/Controls: N = 96)*

*(Schwab et al, AJRCCM 168; 522-530, 2003)*

#### Adjusted Odds Ratio (OR) for Sleep Apnea:

<table>
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<tr>
<th>Soft Tissue Volume</th>
<th>OR</th>
<th>95% CI</th>
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<tr>
<td>Fat pads</td>
<td>1.64</td>
<td>1.00 - 2.81</td>
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<tr>
<td>Lateral Walls</td>
<td>6.01*</td>
<td>2.62 - 17.14</td>
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<tr>
<td>Soft Palate</td>
<td>1.66</td>
<td>0.99 - 3.18</td>
</tr>
<tr>
<td>Tongue</td>
<td>6.55*</td>
<td>2.81 - 19.42</td>
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<tr>
<td>Total Soft Tissue</td>
<td>6.95*</td>
<td>3.08 - 19.11</td>
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</tbody>
</table>

*§Adjusted for gender, ethnicity, age, craniofacial size and visceral neck fat

* = Significant
Airway Closure During Sleep - Apneic

Wakefulness

Sleep

3D Airway

Retropalatal Axial Sections

3D Airway
Endocrine/Metabolic Risk Factors for OSA

- Hypothyroidism
- Acromegaly
- Polycystic ovarian syndrome
- Testosterone replacement
- Postmenopause
- Cushing’s Syndrome
- Diabetes Mellitus
- Atherosclerosis/metabolic syndrome
- Inflammation/oxidative stress
Undiagnosed Sleep Disordered Breathing in Obese Patients with Type 2 Diabetes (N=305)  
Foster et al, Diabetes Care (2009)

- Examined 305 obese type 2 diabetics to determine the severity and prevalence of OSA:
  - 13.4% - normal (AHI < 5 events/hour)
  - 33.4 % - mild OSA (AHI 5 - 15 events/hour)
  - 30.5% - moderate OSA (AHI 15 - 30 events/hour)
  - 22.6% - severe OSA (AHI > 30 events/hour)

- Exceedingly high prevalence (86.6%) of OSA among obese patients with type 2 diabetes
Consequences of Obstructive Sleep Apnea

- Hypertension
- Right and left congestive heart failure
- Nocturnal arrhythmias
- Myocardial infarction
- Pulmonary hypertension
- Stroke
Consequences of Obstructive Sleep Apnea

- Cognitive impairment
- Sexual dysfunction
- Injury due to automobile accidents
- Injury due to work-related accidents
- Death
Tracking Errors Produced by Ethanol and Obstructive Sleep Apnea

(Sleep apnea impairs driving performance)
Sleep Heart Health Study: A Cross-sectional Analysis for Hypertension (Nieto et al, JAMA 283:1829, 2000)

Conclusion – Sleep apnea is an independent risk factor for systemic hypertension
Dose-Response Curves for CVD and SDB
(Shahar E et al., AJRCCM 163:19-25, 2001)
## Cardiovascular Outcomes in Men with Obstructive Sleep Apnea

<table>
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<tr>
<th></th>
<th>Healthy men (n=264)</th>
<th>Simple snorers (n=377)</th>
<th>Untreated mild-moderate OSAH (n=403)</th>
<th>Untreated severe OSAH (n=235)</th>
<th>OSAH treated with CPAP (n=372)</th>
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<td><strong>Non-fatal cardiovascular events</strong></td>
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<tr>
<td>Number of events</td>
<td>12</td>
<td>22</td>
<td>36</td>
<td>50</td>
<td>24</td>
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<td>Events per 100 person years</td>
<td>0.45</td>
<td>0.58</td>
<td>0.89</td>
<td>2.13*</td>
<td>0.64</td>
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<td><strong>Cardiovascular death</strong></td>
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<td>Number of events</td>
<td>8</td>
<td>13</td>
<td>22</td>
<td>25</td>
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<td>Events per 100 person years</td>
<td>0.3</td>
<td>0.34</td>
<td>0.55</td>
<td>1.06†</td>
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OSAH=obstructive sleep apnoea-hypopnoea syndrome; CPAP=continuous positive airway pressure. *p<0.0001 versus healthy men; †p=0.0012.

**Table 2: Incidence of cardiovascular events during the 10-year follow-up in healthy men, snorers, and patients untreated and treated for OSAH**

Marin et al. Lancet 365:1046-1053, 2005
Recurrence of Atrial Fibrillation Following Cardioversion is Higher in Patients with Untreated OSA (Kanagala et al, Circ 107:2589, 2003)

% Recurrence at 12 Months

- Controls (n=79)
- Treated OSA (n=12)
- Untreated OSA (n=27)

*p < 0.009 compared to controls
**p < 0.013 compared to treated OSA
Increased Mortality in OSA (Wisconsin Sleep Cohort)

Young et al.  
Sleep 31:1071-8, 2008

**Total Sample**

<table>
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<tr>
<th>% Surviving</th>
<th>AHI &lt; 5</th>
<th>AHI 5-15</th>
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**Sample Excluding CPAP Treated Participants**

<table>
<thead>
<tr>
<th>% Surviving</th>
<th>AHI &lt; 5</th>
<th>AHI 5-15</th>
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- Death related to sleep apnea
- Underwent a PSG one week before death - he found the mask uncomfortable
- No history of heart problems
Conclusions – OSA

- Pay attention to upper airway anatomy
- Upper airway soft tissue structures are enlarged in patients with sleep apnea
- OSA is an inflammatory disorder and may be linked to atherosclerosis
- OSA is extremely common in obese type 2 diabetics
- Sleep apnea is associated with significant cardiovascular consequences
- Atrial fibrillation commonly recurs in patients with sleep apnea
Thank you for your attention!

Any Questions?

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