Adult and Pediatric Obstructive Sleep Apnea

Kevin Katzenmeyer, MD
Faculty Advisor: Ronald W. Deskin, MD
The University of Texas Medical Branch
Department of Otolaryngology
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Obstructive Sleep Apnea

- 1-4% of population
- *Pickwick Papers* (1837)
- Osler (1906)
- Guilleminault (1973) - OSAS
Obstructive Sleep Apnea

- 85% of adult patients are male
- Men 4%, Female 2%
- 2/3rd obese
- Contributes to HTN and cardiovascular disease
- Increased motor vehicle accidents
Pathophysiology

- Pharyngeal collapse
- Decreased airway patency
- Increase in negative pressure
- Becomes a vicious cycle
Pathophysiology

- Anatomic narrowing
  - Requires increased inspiratory pressures
- Abnormal neuromuscular control
  - Reflex activation of dilators in response to airway obstruction often fails
Diagnosis

Morphometric index = morphometric component + obesity component

Index = $P + ([Mx - Mn] + 3 \times OJ) + (BMI - 25) \times (NC/BMI)$

A value $>70$ indicates a risk of obstructive sleep apnea syndrome.

**Key:**
- $P$ Height of the palate from the incisors (mm)
- $Mx$ Maxillary molar width (mm)
- $Mn$ Mandibular molar width (mm)
- $OJ$ Incisor overjet (mm)
- $BMI$ Body mass index (kg/m$^2$)
- $NC$ Neck circumference (cm)
Diagnosis

- History
- Physical examination
- Radiographs
- Polysomnogram
History

- Snoring*
- Excessive daytime sleepiness*
- Restless sleep
- Personality changes
- Headaches
- Sexual dysfunction
- Job performance
- Sleep hygiene
- Bed partner’s input *
Physical Exam

- Vital signs
- Head & Neck exam
- Flexible endoscopy
Vital signs

- Height
- Weight
- Collar size
- Blood pressure
- Calculate BMI
  - Wt (kg) / Ht (meters) squared
  - Men >27.8, Women >27.3
Examination

- Tongue
- Palate
- Uvula
- Tonsils
- Nasal cavity
- Hyoid
- Mandible
- Maxilla
Mallampati classification

Figure 3. Mallampati presentation: Grades 1–3.
Muller’s Maneuver

Figure 6. Flexible fiberoptic view of the retropalatal region at rest and with Müller maneuver. A 90% collapse of the retropalatal region is noted here. (Courtesy of Richard J. Schwab, MD, Philadelphia, PA.)
Baseline
(quiet breathing)

10 cm H₂O

20 cm H₂O

30 cm H₂O

40 cm H₂O
Exam
Radiography

- Cephalometrics
- Computed tomography
- Magnetic resonance imaging
Cephalometrics

- Standardized lateral radiographs
- Examines bony and soft-tissue structure
- Two-dimensional evaluation
- Lack of volumetric data
- Maxillomandibular surgery, oral appliances
Computed tomography

- Supine
- Volumetric reconstruction
- Disadvantages
  - Cost
  - Weight limitations
  - Ionizing radiation
Magnetic Resonance Imaging

- Excellent soft tissue anatomy
- Multiple planes
- No ionizing radiation

Disadvantages
- Cost
- Weight limitations
- Noisy
- Claustrophobia
Polysomnogram

- EEG
- EKG
- Submental EMG
- Anterior tibialis EMG
- EOG
- Nasal/oral airflow
- Pulse oximetry
- Respiratory movement
- Sleeping position
- Esophageal manometry
Polysomnogram

- Obstructive apnea – cessation of airflow for at least 10 seconds with respiratory effort
- Central apnea – cessation of airflow for at least 10 seconds without respiratory effort
- Mixed apnea – characteristics of both for at least 10 seconds
- Hypopnea – hypoventilation secondary to partial obstruction
Polysomnogram

- Apnea index
- Apnea-Hypopnea index = respiratory disturbance index
- Arousal index

<table>
<thead>
<tr>
<th></th>
<th>RDI</th>
<th>SaO₂ (%)</th>
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<tbody>
<tr>
<td>Mild</td>
<td>5–20</td>
<td>&gt;85</td>
</tr>
<tr>
<td>Moderate</td>
<td>21–40</td>
<td>65–84</td>
</tr>
<tr>
<td>Severe</td>
<td>&gt;40</td>
<td>&lt;65</td>
</tr>
</tbody>
</table>

RDI, respiratory disturbance index (mean number of apneas and hypopneas per hour of sleep); SaO₂, arterial oxyhemoglobin saturation recorded during sleep.
Treatment

- Nonsurgical modalities
- Surgical modalities
Nonsurgical Treatment

- Weight loss
- Sleep hygiene
- Pharmacotherapy
- Nasal continuous positive airway pressure
- Oral appliances
Nonsurgical Treatment

- Weight loss
  - Get below “trigger weight”
  - Diet, exercise, bariatric surgery, medications

- Sleep hygiene
  - Avoidance of sedatives
  - Positional changes
Pharmacotherapy

- Protriptyline – decreases REM sleep
- Xanthine based drugs
- Steroids
- Antibiotics
- Nasal medications
CPAP

- 1981
- Very effective
- Can be modified and used on a trial basis
CPAP
CPAP

- Titrated to limit all respiratory events
- 50-90% acceptance – better if daytime symptoms improved
- Side effects in 40-50%
CPAP
Oral appliances

- Advances the mandible
- Retains the tongue anteriorly
Oral appliances

- Most effective in nonobese patients with retro or micrognathia
- Better for mild to moderate cases
- 51% achieve normal sleep, 61% improved RDI < 20
- Consider TMJ dysfunction and occlusal changes
Surgical Treatment

- Retropalatal obstruction
- Retrolingual obstruction
UPPP

- Fujita (1981)
- Most common procedure
- 1st line tx for retropalatalal collapse
- 10-50% success
Tongue reduction

- Lingual tonsillectomy
- Laser midline glossectomy
- Lingualplasty
- Radiofrequency volumetric tissue reduction
Mandibular Osteotomy with Genioglossus Advancement

- Enlarges the retrolingual airway without disturbing dentition
- Prevents retrolingual collapse
Hyoid Myotomy and Suspension

- Enlarges retrolingual airspace
- Advances the tongue base and epiglottis anteriorly
Maxillomandibular Osteotomy and Advancement

- Severe disease
- Failure with more conservative measures
- Midface, palate, and mandible advanced anteriorly
- Limited by ability to stabilize the segments and aesthetic facial changes
Nasal surgery

- Improved symptoms and CPAP
  - Septoplasty
  - Turbinate reduction
  - Functional nasal reconstruction
Tracheostomy

- Bypasses all areas of obstruction
- Virtually 100% effective
- Two indications
  - Temporary procedure during airway reconstruction
  - Severe OSA when CPAP refused, ineffective, or not tolerated or if other conditions exacerbated by the apneas
- Line the tract with skin flaps
- Lack of social acceptance
History and physical examination are suggestive of OSDB

PVG shows increased arousals and sleep disruption

AI 5-20

AI > 20

AI <5

General management: weight loss, avoidance of ETOH and sedatives, and sleep position modifications

Symptomatic or cardiovascular risk factors are present

No

Yes

Routine follow up

Anatomic obstruction

Upper airway resistance syndrome

Yes

No

Multiple sleep latency test (MSLT) and Re-evaluation

Anatomic obstruction

Yes

Corrective surgery

Response

Yes

No

CPAP and/or Intra-oral appliances

Yes

No

Follow up
Algorithm

- Weight loss
- CPAP
- Consider oral appliances for milder cases
Riley-Powell-Stanford Protocol

Presurgical Evaluation
(Physical Examination, Cephalometric Analysis, Fiberoptic Pharyngoscopy)

Phase I
(Site of Obstruction)

UPPP
(Type 1 Oropharynx)

UPPP+MOHM
(Type 2 Oropharynx - Hypopharynx)

MOHM
(Type 3 Hypopharynx)

Postoperative Polysomnogram (6 Months)
(Failure)

Phase II
MMO
Riley-Powell-Stanford Protocol

- Post operative PSG at 6 months
- Phase I = 61% success
- Phase II = 95-100% success
Pediatric OSAS

- Many features are different
- 2% of children
- Males = Females
- Peak at age 2-5
- Peak OSA = Peak ATH
Pediatric OSAS

- Snoring – severity not predictive
- Many are mouth breathers
  - Adenoid facies (15% have OSAS)
- Excessive daytime sleepiness
- Obesity vs. FTT
- Increased respiratory effort
Pediatric OSAS

- Parasomnias
- Restless sleep
- Aggressive behavior
- Learning disabilities
- Enuresis
<table>
<thead>
<tr>
<th>Nocturnal</th>
<th>Daytime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apnea</td>
<td>Mouth breathing</td>
</tr>
<tr>
<td>Snoring</td>
<td>Hypersomnolence (excessive daytime sleepiness)</td>
</tr>
<tr>
<td>Pauses with breathing at night</td>
<td>Poor school performance</td>
</tr>
<tr>
<td>Frequent awakenings from sleep, restless sleep</td>
<td>Abnormal daytime behavior</td>
</tr>
<tr>
<td>Nightmares</td>
<td>Aggression</td>
</tr>
<tr>
<td>Nocturnal enuresis</td>
<td>Hyperactivity</td>
</tr>
<tr>
<td>Nocturnal diaphoresis</td>
<td>Discipline problems</td>
</tr>
<tr>
<td>Cyanosis*</td>
<td>Short attention span</td>
</tr>
<tr>
<td>Near sudden infant death syndrome*</td>
<td>Morning headache</td>
</tr>
<tr>
<td></td>
<td>Weight problem (failure to thrive or obesity)</td>
</tr>
<tr>
<td></td>
<td>Frequent upper respiratory tract infections</td>
</tr>
<tr>
<td></td>
<td>Chronic rhinorrhea</td>
</tr>
<tr>
<td></td>
<td>Dysphagia</td>
</tr>
<tr>
<td></td>
<td>School and learning problems</td>
</tr>
<tr>
<td></td>
<td>Feeding difficulties*</td>
</tr>
</tbody>
</table>

*Neonatal/infant.
Pediatric OSAS

- Impaired growth
  - Possible impairment of release or end-organ response to GH
  - Increased caloric effort with respiration
  - Difficulty with eating
- Cor pulmonale
- Associated with GERD
<table>
<thead>
<tr>
<th></th>
<th>Adult</th>
<th>Child</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snoring</td>
<td>Alternating, with pauses</td>
<td>Continuous</td>
</tr>
<tr>
<td>Excessive daytime</td>
<td>Main symptom</td>
<td>Infrequent</td>
</tr>
<tr>
<td>sleepiness</td>
<td>Very common</td>
<td>Infrequent</td>
</tr>
<tr>
<td>Obesity</td>
<td>Not reported</td>
<td>Fairly common</td>
</tr>
<tr>
<td>Failure to thrive/</td>
<td>Usually not</td>
<td>Common</td>
</tr>
<tr>
<td>underweight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouth breathing</td>
<td>Yes (8-10:1)</td>
<td>No (1:1 prepubertal)</td>
</tr>
<tr>
<td>Male preponderance</td>
<td>Uncommon</td>
<td>Most common</td>
</tr>
<tr>
<td>Enlarged tonsils and</td>
<td>Apnea</td>
<td>Hypopnea</td>
</tr>
<tr>
<td>adenoids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Most common obstructive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pattern</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arousal on apnea</td>
<td>Very common</td>
<td>Uncommon</td>
</tr>
<tr>
<td>termination</td>
<td>Very common</td>
<td>Uncommon</td>
</tr>
<tr>
<td>Sleep pattern disruption</td>
<td>Very common</td>
<td>Cardiopulmonary, FTT, behavior, perioperative</td>
</tr>
<tr>
<td>Complications</td>
<td>Cardiopulmonary, EDS</td>
<td></td>
</tr>
<tr>
<td>Surgery as treatment</td>
<td>Selected cases, minority</td>
<td>Most cases, T&amp;A, UP3</td>
</tr>
<tr>
<td></td>
<td>UP3</td>
<td></td>
</tr>
<tr>
<td>CPAP as treatment</td>
<td>Most common treatment</td>
<td>Selected cases, minority</td>
</tr>
<tr>
<td>Mortality</td>
<td>Death during sleep, CVS</td>
<td>Usually perioperative</td>
</tr>
</tbody>
</table>
The child who always snores, has restless sleep secondary to obstruction, & has apneic episodes per the parents virtually always has PSG confirmation (Brouillette)
Polysomnogram

- Not cost effective
- Considerations
  - CNS disease
  - Age < 2
  - Increased surgical risks
  - Family desires
  - Discordant exam
### Table 7. ABNORMAL VALUES ON PEDIATRIC POLYSOMNOGRAPHY

<table>
<thead>
<tr>
<th>Condition</th>
</tr>
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<tbody>
<tr>
<td>AI &gt; 1</td>
</tr>
<tr>
<td>AHI &gt; 5</td>
</tr>
<tr>
<td>CO$_2$ 50 mm Hg &gt; 10% sleep time</td>
</tr>
<tr>
<td>CO$_2$ 45 mm Hg &gt; 60% sleep time</td>
</tr>
<tr>
<td>Minimum O$_2$ saturation &lt; 92% (95%)</td>
</tr>
</tbody>
</table>

AHI = apnea/hypopnea index; AI = apnea index.
Diagnosis

- Lateral neck radiographs
- Chest x-rays
- EKG
Treatment

- Tonsillectomy & adenoidectomy

<table>
<thead>
<tr>
<th>Author</th>
<th>Procedure</th>
<th>N</th>
<th>Patients</th>
<th>% Cure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nishimura</td>
<td>T &amp; A</td>
<td>55</td>
<td>Child</td>
<td>94</td>
</tr>
<tr>
<td>Kudoh</td>
<td>T &amp; A</td>
<td>31</td>
<td>Obese</td>
<td>All</td>
</tr>
<tr>
<td>Suen</td>
<td>T &amp; A</td>
<td>26</td>
<td>Child</td>
<td>84</td>
</tr>
<tr>
<td>Wiet</td>
<td>T &amp; A UPPP</td>
<td>48</td>
<td>Comp</td>
<td>54</td>
</tr>
<tr>
<td>Frank</td>
<td>T &amp; A</td>
<td>32</td>
<td>Child</td>
<td>Most</td>
</tr>
</tbody>
</table>

T & A = tonsillectomy and adenoidectomy; UPPP = uvulopalatopharyngoplasty.
Treatment

- UPPP
- genioglossus advancement
- Maxillomandibular advancement
- CPAP
- Tracheotomy
Down Syndrome

- OSAS = 54-100%
- Physical factors
  - Small midface and cranium
  - Narrow nasopharynx
  - Large tongue
  - Muscular hypotonia
  - Obesity
  - Small larynx
- Congenital heart disease / cor pulmonale
- UPPP
Craniofacial anomalies

- Mandibular hypoplasia
  - Pierre-Robin sequence
- Maxillary hypoplasia
  - Treacher-Collins
  - Crouzons
- Tracheotomy
Case report

- 1 month old baby presents to ER with difficulty breathing, feeding, and cyanotic episodes


Maddern BR. Obstructive Sleep Disorders. In Pediatric Otolaryngology by Bluestone, Stool, and Kenna. 2nd ed. Pages 1067-1076.


