Sleep Disorders for the Otolaryngologist

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Grand Rounds Presentation
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Background

• One-half to one-third of life asleep
• Physiologic need for sleep poorly understood
• Sleep medicine relatively new field
Milestones

- 1837 – Dickens – describes overweight/hypersomnolent boy in the *Posthumous Papers of the Pickwick Club* (term “pickwickian” used by Osler)

- 1875 – Caton – EEG in dogs

- 1928 – Berger – Human EEG alpha waves

- 1937 – Loomis – EEG Sleep stages described
Milestones

- 1953 – Aserinsky & Kleitman – REM sleep
- 1970s – Polysomnography
- 1972 – Guilleminault – coins term OSA
- 1990 – International Classification of Sleep Disorders
Sleep Physiology

• What is Sleep?
  – “a reversible behavioral state of perceptual disengagement from and unresponsiveness to the environment”
• 75% in Non-REM sleep
• 25% REM sleep – muscle atonia, autonomic activation
## Sleep Architecture (young adult)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Arousal threshold</th>
<th>EEG pattern</th>
<th>Sleep distribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NREM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Low</td>
<td>Theta waves</td>
<td>2–5</td>
</tr>
<tr>
<td>2</td>
<td>High</td>
<td>Sleep spindles</td>
<td>45–55</td>
</tr>
<tr>
<td>3</td>
<td>Higher</td>
<td>Delta waves</td>
<td>3–8</td>
</tr>
<tr>
<td>4</td>
<td>Highest</td>
<td>Delta waves</td>
<td>10–15</td>
</tr>
<tr>
<td>REM</td>
<td>Variable</td>
<td>Sawtooth waves</td>
<td>20–25</td>
</tr>
</tbody>
</table>
Sleep Disorders

- Dyssomnias
- Parasomnias
- Medical-Psychiatric
- Proposed
Dyssomnias

• Disorder of insomnia or excessive sleepiness

• Three subdivisions:
  – Intrinsic
  – Extrinsic
  – Circadian rhythm disorders
### ICSD

**Dyssomnias**

- Intrinsic sleep disorders
  - Psychophysiological insomnia
  - Sleep state misperception
  - Idiopathic insomnia
  - Narcolepsy
  - Recurrent hypersomnia
  - Idiopathic hypersomnia
  - Posttraumatic hypersomnia
  - Obstructive sleep apnea syndrome
  - Central sleep apnea syndrome
  - Central alveolar hypoventilation syndrome
  - Periodic limb movement disorder
  - Restless legs syndrome

- Extrinsic sleep disorders
  - Inadequate sleep hygiene
  - Environmental sleep disorder
  - Altitude insomnia
  - Adjustment sleep disorder
  - Insufficient sleep syndrome
  - Limit-setting sleep disorder
  - Sleep-onset association disorder
  - Food allergy insomnia
  - Nocturnal eating (drinking) syndrome
  - Hypnotic-dependent sleep disorder
  - Stimulant-dependent sleep disorder
  - Alcohol-dependent sleep disorder
  - Toxin-induced sleep disorder

- Circadian rhythm sleep disorders
  - Time zone change (jet lag) syndrome
  - Shift work sleep disorder
  - Irregular sleep-wake pattern
  - Delayed sleep phase syndrome
  - Advanced sleep phase syndrome
  - Non-24-hour sleep-wake disorder
Parasomnias

• Inappropriate CNS activation
• Four subdivisions:
  – Arousal disorders
  – Sleep-wake transition disorders
  – Parasomnias associated with REM sleep
  – Other
ICSD
Parasomnias

Parasomnias
- Arousal disorders
  - Confusional arousals
  - Sleepwalking
  - Sleep terrors
- Sleep-wake transition disorders
  - Rhythmic movement disorder
  - Sleep starts
  - Sleep talking
  - Nocturnal leg cramps
- Parasomnias usually associated with REM sleep
  - Nightmares
  - Sleep paralysis
  - Impaired sleep-related penile erections
  - Sleep-related painful erections
  - REM sleep-related sinus arrest
  - REM sleep behavior disorder
- Other parasomnias
  - Sleep bruxism
  - Sleep enuresis
  - Sleep-related abnormal swallowing syndrome
  - Nocturnal paroxysmal dystonia
  - Sudden unexplained nocturnal death syndrome
  - Primary snoring
  - Infant sleep apnea
  - Congenital central hypoventilation syndrome
  - Sudden infant death syndrome
  - Benign neonatal sleep myoclonus
Sleep disorders associated with medical/psychiatric disorders

Associated with mental disorders
  - Psychoses
  - Mood disorders
  - Anxiety disorders
  - Panic disorders
  - Alcoholism

Associated with neurological disorders
  - Cerebral degenerative disorders
  - Dementia
  - Parkinsonism
  - Fatal familial insomnia
  - Sleep-related epilepsy
  - Electrical status epilepticus of sleep
  - Sleep-related headaches

Associated with other medical disorders
  - Sleeping sickness
  - Nocturnal cardiac ischemia
  - Chronic obstructive pulmonary disease
  - Sleep-related asthma
  - Sleep-related gastroesophageal reflux
  - Peptic ulcer disease
  - Fibrositis syndrome
ICSD Proposed Sleep Disorders

- Proposed sleep disorders
- Short sleeper
- Long sleeper
- Subwakefulness syndrome
- Fragmentary myoclonus
- Sleep hyperhidrosis
- Menstrual-associated sleep disorder
- Pregnancy-associated sleep disorder
- Terrifying hypnagogic hallucinations
- Sleep-related neurogenic tachypnea
- Sleep-related laryngospasm
- Sleep choking syndrome
Otolaryngologic Sleep Disorders

• Sleep-Disordered Breathing
  – Obstructive Sleep Apnea Syndrome (OSAS)
  – Obstructive Sleep Hypopnea Syndrome (OSHS)
  – Upper Airway Resistance Syndrome (UARS)
• Snoring
Definitions

- Apnea – cessation of airflow > 10 sec, ends in arousal
- Hypopnea – reduction in airflow with desaturation, ends in arousal
- Apnea / Hypopnea Index (Respiratory Disturbance Index)
Syndromes

• **OSAS**: RDI >5
• **UARS**: RDI<5, excessive daytime somnolence, elevated intrathoracic pressure
• **Primary Snoring**: no polysomnogram abnormalities
<table>
<thead>
<tr>
<th>Severity</th>
<th>RDI</th>
<th>SaO2 (%)</th>
</tr>
</thead>
<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>
Pathophysiology

- **Anatomy**
  - Obesity
  - Nasal Obstruction
  - Pharyngeal Obstruction
    - Jaw
    - Tongue
    - Palate

- **Physiology**
  - Failure of dilator muscles
  - Excessive intrathoracic pressure
Levels of Obstruction

Anatomic Abnormalities

1. Septal deviation
2. Turbinate hypertrophy
3. Nasal polyps
4. Adenoid hypertrophy
5. Elongation of soft palate and uvula
6. Tonsillar hypertrophy
7. Macroglossia
8. Retrognathia
9. Rugae (vertical) of posterior pharyngeal wall
10. Omega shaped epiglottis
11. Laryngeal-tracheal stenosis
Why do we need to treat OSA?
Consequences of OSA

- Hypertension
- Ischemic heart disease
- Myocardial dysfunction & arrhythmias
- Cerebrovascular disease
- Mood, neurocognitive, behavioral
  - Increased industrial/traffic accidents
- Increased mortality
OSA Consequences

Primary events

- Sleep onset
- Apnea
- \(\text{\textit{\text{\text{\textsuperscript{4}}}}} \text{O}_2, \text{\text{\text{\textsuperscript{4}}}}} \text{CO}_2, \text{\text{\text{\textsuperscript{4}}}}} \text{pH}

Physiologic consequences

- Vagal bradycardia
- Ectopic cardiac beats
- Pulmonary vasoconstriction
- Systemic vasoconstriction
- Stimulation of erythropoiesis
- Cerebral dysfunction
- Loss of deep sleep
- Sleep fragmentation
- Excessive motor activity

Clinical features

- Unexplained nocturnal death
- Pulmonary hypertension
- Right heart failure
- Systemic hypertension
- Polycythemia
- Excessive daytime sleepiness
- Intellectual deterioration
- Personality changes
- Behavioral disorders
- Restless sleep

Resumption of airflow

Return to sleep
EFFECT OF AI ON MORTALITY (UNTREATED, ALL AGES)

CUMULATIVE SURVIVAL

ENTRY 1 2 3 4 5 6 7 8 9

INTERVAL (YEARS)

AI < 20

AI > 20
Diagnosis
History

- Bed partner / family
- Observed apneas
- Epworth Sleepiness Scale
- Medications/alcohol/caffeine
- Sleep hygiene
History

- Nocturnal signs and symptoms
  - Heroic snoring
  - Restless disturbed sleep
  - Observed gasping or apnea
  - Nocturnal sweating

- Daytime signs and symptoms
  - Excessive daytime sleepiness
  - Cognitive impairment
  - Morning headaches
  - Impotence
Risk Factors

- Male gender
- Obese (increased BMI)
- Increased age
- Neck size > 17
- Snoring
- Disfavorable anatomy
Physical Exam

• Vital signs and body mass index
  – BMI: weight (kg) ÷ height² (meters)
• Complete head and neck examination
• Fiberoptic endoscopy—Müller maneuver
Physical Exam

- **Nasal**
  - Pre/post decongestant
  - Nasal valve collapse
  - Septum/turbs/polyps
- **Neck**
  - Size
  - Mass/LAD/thyroid
- **OC/OP**
  - Tonsils
  - Palate
  - Tongue
  - Jaw
- **Scope**
  - R/O tumor
  - Müller maneuver
Physical Findings

- Nasal obstruction
- Tonsillar/adenoid hypertrophy
- Macroglossia
- Reflux laryngitis
- Shirt collar size greater than 17 inches
- Hypothyroidism with goiter
- Truncal obesity
- Hypertension
- Congestive heart failure
- Pittling edema of lower extremities
- Enlargement of hands and feet (acromegaly)

Symptoms

- Excessive daytime fatigue
- Snoring
- Heartburn
- Memory loss
- Irritability
- Depression
- Morning headache
- Shortness of breath
- Nocturia
- Impotence
Palate Variations

- Natural type
- Elongated uvula
- Enlarged uvula
- Parallel type
- Webbed type
- Large tongue dorsum
- Tonsillar hypertrophy
- Shallow oropharynx
- Posterior arch narrowing
- Bifid uvula
- Imbedded type
- Emerging type
- Anterior arch narrowing
- Wide soft palate
- Hypertrophy of the lateral pharyngeal folds
Physical Exam

• Short, thick neck
• Communication with anesthesiologist key
Müller Maneuver

- Designed to look for site of airway collapse
- While scope is in, patient inspires against closed nostrils/mouth
Muller Maneuver

- BOT collapse
- Hypopharynx collapse
Muller Maneuver

- Predominant collapse is lateral pharyngeal walls
Evaluation Tools

- Polysomnography
- Multiple Sleep Latency Test
- Cephalometrics
- Thyroid Function Tests
- Cardiac Evaluation

- H&P not very sensitive/specific
Polysomnography

- Standards vary from lab to lab
- Includes:
  - EEG
  - Electro-oculogram
  - EMG (submental, tibialis)
  - Nasal/oral airflow
  - Respiratory movement
  - Oximetry
  - EKG
  - Position
Polysomnography

• May do split-night CPAP titration
  – Positive in first half – OK to titrate
  – Negative first half does not exclude OSAS
• Efforts underway to evaluate limited/home studies
Apnea Tracings

<table>
<thead>
<tr>
<th>Type</th>
<th>Wake</th>
<th>Sleep</th>
<th>Wake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstructive apnea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airflow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory effort</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed apnea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airflow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory effort</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central apnea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airflow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory effort</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypopnea</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Airflow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory effort</td>
<td></td>
<td></td>
<td></td>
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</table>
Cephalometrics

Table 1. CEPHALOMETRIC MEASUREMENTS ASSOCIATED WITH OBSTRUCTIVE SLEEP APNEA

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
<th>Association with OSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPH</td>
<td>Mandibular plane to hyoid</td>
<td>Inferiorly positioned in OSA</td>
</tr>
<tr>
<td></td>
<td>(Normal = 17 ± 6 mm)</td>
<td></td>
</tr>
<tr>
<td>PAS</td>
<td>Posterior airway space. Distance from pharynx to tongue measured on a line</td>
<td>Narrow in OSA</td>
</tr>
<tr>
<td></td>
<td>from point B to gonion</td>
<td>(Normal = 10 ± 3 mm)</td>
</tr>
<tr>
<td>SNB</td>
<td>Angle of sella to nasion to point B</td>
<td>Decreased in OSA</td>
</tr>
<tr>
<td></td>
<td>(Normal = 80 ± 4°)</td>
<td></td>
</tr>
<tr>
<td>FMA</td>
<td>Frankfort-mandibular plane angle</td>
<td>Increased in OSA</td>
</tr>
<tr>
<td></td>
<td>(Normal = 24 ± 5°)</td>
<td></td>
</tr>
<tr>
<td>PNS-P</td>
<td>Soft palate length</td>
<td>Increased in OSA</td>
</tr>
<tr>
<td></td>
<td>(Normal = 42 ± 5 mm)</td>
<td></td>
</tr>
</tbody>
</table>

Other Measurements Studied

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
<th>Association with OSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cd-Gn</td>
<td>Mandibular length (condyle to gnathion)</td>
<td>Decreased in OSA</td>
</tr>
<tr>
<td></td>
<td>(Normal = 122 ± 6 mm)</td>
<td></td>
</tr>
<tr>
<td>PNS-ANS</td>
<td>Maxillary length (posterior nasal spine to anterior nasal spine)</td>
<td>Decreased in OSA</td>
</tr>
<tr>
<td></td>
<td>(Normal = 88 ± 4 mm)</td>
<td></td>
</tr>
<tr>
<td>Tng Ht</td>
<td>Tongue height (perpendicular distance from tip to epiglottis base)</td>
<td>Increased in OSA</td>
</tr>
<tr>
<td></td>
<td>(Normal = 39 ± 8 mm)</td>
<td></td>
</tr>
<tr>
<td>ANS-N</td>
<td>Maxillary height (anterior nasal spine to nasion)</td>
<td>Increased in OSA</td>
</tr>
<tr>
<td></td>
<td>(Normal = 57 ± 4 mm)</td>
<td></td>
</tr>
<tr>
<td>SNA</td>
<td>Sella to nasion to point A</td>
<td>Decreased in OSA</td>
</tr>
<tr>
<td></td>
<td>(Normal = 83 ± 4°)</td>
<td></td>
</tr>
<tr>
<td>S-N</td>
<td>Cranial base length (sella to nasion)</td>
<td>Decreased in OSA</td>
</tr>
<tr>
<td></td>
<td>(Normal = 7.5 ± 3 mm)</td>
<td></td>
</tr>
<tr>
<td>N-S-Ba</td>
<td>Cranial base angle (Nasion to sella to basion)</td>
<td>Acute in OSA</td>
</tr>
<tr>
<td></td>
<td>(Normal = 129 ± 5°)</td>
<td></td>
</tr>
</tbody>
</table>

Multiple Sleep Latency Test

- Allowed to fall asleep 4-5 times in a day
- Time to sleep (latency) measured
- Abnormally quick may be pathologic
  - Narcolepsy
  - Upper Airway Resistance Syndrome
Treatment
Treatment

- Non-surgical
  - Weight loss
  - Sleep hygiene
  - CPAP
  - Oral appliances

- Surgical
  - Nasal
  - Retropalatal
  - Retrolingual
  - Tracheotomy
## Table 1. TREATMENT PHILOSOPHY

1. Treatment to cure
2. Site-specific surgical therapy
3. Staged surgical management (if necessary)
4. Full patient disclosure of options and risks
5. Follow-up all treatment
Judging Success

• Many define as 50% decrease in RDI and RDI < 20

• Objective assessment of response – post-treatment polysomnogram
  – Logistically often difficult to obtain
Weight Loss

- Note lateral pharyngeal fat pads
Sleep Hygiene

- Limit caffeine, alcohol
- Avoid bedtime TV, reading
- May sew tennis ball into T-shirt to avoid supine position
Positive Airway Pressure

- CPAP or BiPAP
- May be delivered nasally or by full-face mask
- May still be necessary after surgery
- Compliance an issue
CPAP Axial MR

- 0.0 cm H₂O
- 5.0 cm H₂O
- 10.0 cm H₂O
- 15.0 cm H₂O
CPAP Effect on Airway
Oral Appliances

• Two basic types
  – Advance tongue
  – Advance mandible

• Best for mild/moderate OSA

• Preferred by many over CPAP
Tongue-Retaining Device
Surgical Treatment

- Nasal
- Palatal
- Tongue Base
- Maxillomandibular
- Tracheotomy
Surgical Treatment

Table 2. SURGICAL INDICATIONS FOR TREATMENT

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>RDI &gt; 20</td>
</tr>
<tr>
<td>2.</td>
<td>Oxyhemoglobin desaturation &lt; 90%</td>
</tr>
<tr>
<td>3.</td>
<td>Altered daytime performance and excessive daytime sleepiness</td>
</tr>
<tr>
<td>4.</td>
<td>Significant cardiac arrhythmias associated with obstructions</td>
</tr>
<tr>
<td>5.</td>
<td>Specific anatomic abnormality identified</td>
</tr>
<tr>
<td>6.</td>
<td>Refused or rejected medical therapy and desire for surgery</td>
</tr>
<tr>
<td>7.</td>
<td>Medically stable enough to undergo the recommended procedure</td>
</tr>
</tbody>
</table>
Anesthesia Considerations

• High rate of comorbidity (COPD, CAD, etc)
• Preop CPAP/BiPAP
• Short, obese neck / retrognathia – setup for disaster unless prepared
• Postop HTN
• Post-obstructive pulmonary edema
• Ikematsu – 1950s – snoring
• Fujita – 1980 – OSA
UPPP Pre/Post
UPPP Pre/Post
UPPP Pre/Post
UPPP Pre/Post
# UPPP Complications

## Table 1. EARLY COMPLICATIONS OF UP-3

<table>
<thead>
<tr>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transient velopharyngeal incompetence</td>
</tr>
<tr>
<td>Wound dehiscence</td>
</tr>
<tr>
<td>Hemorrhage</td>
</tr>
<tr>
<td>Wound infection</td>
</tr>
</tbody>
</table>

## Table 2. LATE COMPLICATIONS OF UP-3

<table>
<thead>
<tr>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharyngeal discomfort, dryness, tightness</td>
</tr>
<tr>
<td>Postnasal secretion</td>
</tr>
<tr>
<td>Food catching in throat</td>
</tr>
<tr>
<td>Inability to initiate swallowing</td>
</tr>
<tr>
<td>Prolonged sore throat</td>
</tr>
<tr>
<td>Taste disturbance</td>
</tr>
<tr>
<td>Speech disturbance</td>
</tr>
<tr>
<td>Tongue numbness</td>
</tr>
<tr>
<td>Permanent velopharyngeal incompetence</td>
</tr>
<tr>
<td>Nasopharyngeal stenosis</td>
</tr>
</tbody>
</table>
Complication Over UPPP
Complication NP Stenosis
LAUP

• Laser-assisted uvulopalatoplasty
• Can be done in office
• Typically multiple sessions
• More common for non-apneic snoring
• Newer data shows poor long-term results
LAUP
Tongue Procedures

- Lingual tonsillectomy
- Laser midline glossectomy / Lingualplasty
  - trach
- Tongue suspension
- RF volumetric tissue reduction
- Mandibular osteotomy/gedioglossus advancement
- Hyoid myotomy & suspension
Genioglossus Advancement
Genioglossus Advancement
Mandibular Exposure
Hyoid Advancement

- Myotomy to free hyoid bone
- Suspended anteriorly to thyroid cartilage
Mandibulomaxillary Advancement
Permanent Trach

- Skin-lined flaps for more permanent tract
- Serves as upper airway bypass
# Riley-Powell-Stanford Protocol

## Phase I Surgery

1. Nasal reconstruction  
2. Uvulopalatopharyngoplasty or uvulopalatal flap  
3. Mandibular osteotomy and genioglossus advancement and/or hyoid myotomy and suspension  
4. Mandibular tori excision

## Phase II Surgery

1. Maxillomandibular osteotomy and advancement  
2. Hyoid myotomy and suspension  
3. Base of tongue surgery  
4. Lingual tonsillectomy
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
Conclusion

• Sleep medicine exciting, relatively new field

• Otolaryngologist is key player
  – Expertise in airway
  – Can offer surgical solutions