Identifying Sites of Obstruction in OSA

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Overview

Importance of identifying the sites of airway obstruction

Techniques for identifying the sites of obstruction

Drug-induced sleep endoscopy

Fujita Classification

Effective surgery directed at site(s) of obstruction
- Nose
- Palate
- Hypopharynx

Fujita Classification
- Type I: Palate
- Type II: Combined
- Type III: Hypopharynx

OSA surgery review (Sher et al. Sleep 1996)
- UPPP “successful” in 41% of all OSA patients
  - 52% Fujita Type I
  - 5.3% Fujita Types II and III
- Conclusion: failure to identify site(s) of obstruction is principal factor in poor results for surgery

Cochrane Collection 2005 review (evidence-based medicine review database)
- “More research should also be undertaken to identify and standardise techniques to determine the site of airway obstructions.”
Identifying the Sites: Ideal Test Characteristics

- Easy: technically simple, non-invasive
- Low cost
- Dynamic assessment while breathing
- Sleeping patient
- Accurate

OSA Severity

Premise: region(s) of upper airway obstruction are related to OSA severity (AHI)

- Mild-moderate OSA is most likely due to collapse at the level of the palate, whereas moderate to severe OSA most likely includes some component of hypopharyngeal collapse

Advantages: easy, low cost, assessment during sleep?
Disadvantage: not accurate: not supported by the evidence, and refuted in some studies

Friedman Stage

<table>
<thead>
<tr>
<th>FS</th>
<th>Tongue Position</th>
<th>Tonsils</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1, 2</td>
<td>3+, 4+</td>
</tr>
<tr>
<td>II</td>
<td>1, 2</td>
<td>0, 1+, 2+</td>
</tr>
<tr>
<td>III</td>
<td>3, 4</td>
<td>3+, 4+</td>
</tr>
<tr>
<td>IV</td>
<td>BMI ≥ 40</td>
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</tbody>
</table>

Advantages
- Easy, low cost
- Associated with UPPP/tonsillectomy outcomes
  - Success: Stage I 81%
  - Stage II 38%
  - Stage III 8%
Corroborated by Li et al. SLEEP 2006

Disadvantages
- Only shows patients who are not Fujita type I
- Does not identify involved structures other than palate/tonsils (to choose adjunctive procedures)
- Theoretical: not a dynamic assessment of sleeping patient
Müller Maneuver
Endoscopic evaluation of awake patient with forced inspiratory effort against closed mouth and nose

Advantages: simple, low cost
Disadvantage: not accurate or useful by itself
  - Patients with primarily retropalatal obstruction by MM had only ~40% cure of OSA after UPPP
    • Sher et al. 1985, Doghramji et al. 1995
    • Petri et al. 1994: MM no predictive value for palate surgery outcome

Lateral Cephalogram
Standardized lateral X-ray of head and neck
Multiple bony and soft tissue measurements
Advantages: easy, low cost, normative data available, IDs patients with less favorable outcomes
Disadvantages
  - Two-dimensional image
  - Awake, upright, and static
  - Does not ID involved structures

Acoustic Analysis
Premise: Different frequency patterns to snoring sounds from different locations—i.e., palate and tongue base
Analysis to determine site and degree of obstruction
  - SNAP home sleep study system

Acoustic Analysis
Problems:
  - Poor differentiation of site(s) of obstruction
    • Eg, multiple types of palate-type snoring
  - Leap of faith: sound intensity and site of sound production does not equal site of obstruction
  - Decrease snoring but not treat airway obstruction?

Palate procedures (UPPP, RF, LAUP, IS) have only 20-25% decrease in palate-type snoring and sound intensity
Imaging (CT, MRI, fluoroscopy)

**Advantage:** Assessment during sleep possible, improve understanding of abnormal OSA anatomy and changes after certain procedures

**Disadvantages**
- CT and MRI can be static (although cine-CT)
- Time-consuming and not inexpensive
- Specific equipment and technical assistance
- Radiation exposure (CT and fluoroscopy)
- Association between static dimensions of airway and surgical outcomes

Single Breath Test

**Patient asleep and wearing CPAP with flexible endoscope in place**
- CPAP pressure reduced for single breath and airway collapse evaluated with flexible endoscope
- CPAP decreases muscle tone—get worst picture of airway?

**University of Alberta group:**
- > 80% in severe OSA (ns=45) collapse at >1 site
- Greater improvement (86%, 6/7) after UPPP in palate-only

**Major disadvantages**
- Time-consuming without sedation (endoscopy)
- Labor-intensive
- Accuracy?: airway collapse occurs over several breaths

Upper Airway Pressure Monitoring

**Pressure transducer catheter with multiple ports**

**Site of obstruction based on patterns of airway pressure changes**

**Disadvantages**
- Only lowest level of obstruction
- Marked reductions in airway size without pressure changes (Woodson and Wooten 1991)

Acoustic/Flextube Reflectometry

**Flexible tube passed through nose, pharynx, and esophagus**

**Narrowings in tube detected based on reflection of sound waves in tube**

**Poor tolerance**
- Not available for clinical or research use (Interacoustics AS)
Acoustic Reflections

Acoustic rhinometry/pharyngometry
  - Variety of uses, including OSA?

Principle: sound introduced in nose or pharynx and is reflected by changes in impedance (cross-sectional area)

Largely limited to awake patients
  - Nose- or mouthpieces
  - Requires immobilization of head and neck

Drug-Induced Sleep Endoscopy

Fiberoptic endoscopy of sedated, sleeping patient
Goal: reproduce SDB seen on PSG

Palate

Tongue
Drug-Induced Sleep Endoscopy

**Advantages:** Dynamic assessment of sleep
- Directly visualize location of obstruction and involved structures
- Valid: greater collapsibility in OSA vs. snorers (Steinhart 2000) and SDB vs. controls (Berry 2005)
- Correlated with outcomes after palate surgery (Iwanaga 2003)
- “Hypopharynx” contains tongue base epiglottis, and lateral pharyngeal walls
  - Can identify involved structures more precisely and potentially direct surgical treatment

**Disadvantages**
- Not easy: requires sedation, somewhat time-consuming
- Sedatives (e.g., benzodiazepines) decrease muscle tone and decrease respiratory drive
  - May artificially worsen OSA and alter pattern of collapse
  - However, REM sleep = decreased muscle tone
  - ID structures most prone to collapse
DISE as stress test for the pharynx
Drug-Induced Sleep Endoscopy: Ongoing Research at UCSF

- 150 studies completed
- Diversity of obstruction patterns—reassuring
- Inter-rater reliability: moderate-high
- Test-retest reliability: moderate; better for HP

Drug-Induced Sleep Endoscopy: Future Directions

- Determining optimal selection of procedures
- Predicting and/or improving surgical outcomes (accuracy)
  - Preliminary: LPW and untreated HP do poorly unless large T
- Improving our understanding of the airway and changes after surgery
  - Possibly, greatest value is with questionable pattern of obstruction or after previous surgery

Site of Obstruction and Surgical Options

<table>
<thead>
<tr>
<th>Current</th>
<th>Future?</th>
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<tbody>
<tr>
<td>Palate/Tonsils</td>
<td>Palate/Tonsils</td>
</tr>
<tr>
<td>Hypopharynx/</td>
<td>Tongue</td>
</tr>
<tr>
<td>Retrolingual</td>
<td>Epiglottis</td>
</tr>
<tr>
<td>Maxillofacial</td>
<td>LPW</td>
</tr>
<tr>
<td>Maxillofacial</td>
<td>Maxillofacial</td>
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</tbody>
</table>
DISE: Association with Surgical Outcomes

<table>
<thead>
<tr>
<th>Site</th>
<th>Procedure</th>
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<tbody>
<tr>
<td>Palate/tonsil</td>
<td>UPPP ± Tonsillectomy</td>
</tr>
<tr>
<td>Tongue</td>
<td>GA</td>
</tr>
<tr>
<td></td>
<td>Partial Glossectomy</td>
</tr>
<tr>
<td></td>
<td>Tongue RF</td>
</tr>
<tr>
<td></td>
<td>Tongue Stabilization</td>
</tr>
<tr>
<td>Epiglottis</td>
<td>Hyoid suspension</td>
</tr>
<tr>
<td>LPW</td>
<td>? (Hyoid, MAD/MMA)</td>
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Conclusions

Identifying the site(s) of airway obstruction in OSA is critical

No single ideal method of identifying site of obstruction, although there are some options

Conclusions

Improving our assessment of the airway may enable targeted, more-effective treatment of OSA with surgery and oral appliances