Physical Examination and Identifying the Sites of Obstruction in OSA

Eric J. Kezirian, MD, MPH
Director, Division of Sleep Surgery
Otolaryngology—Head and Neck Surgery
University of California, San Francisco
ekezirian@ohns.ucsf.edu
Sleepsurgery.ucsf.edu
Disclosures

The following personal financial relationships with commercial interests relevant to this presentation existed during the past 24 months:

Consultant Apneon
Consultant Medtronic
Consultant Pavad Medical

Consultant/Advisory Board Apnexit Medical
Overview

Goals of evaluation

Pharyngeal anatomy and evaluation

Importance of identifying the sites of airway obstruction

Techniques for identifying the sites of obstruction
Goal of Evaluation

Characterize disorder to guide effective treatment
Major sites of potential airway obstruction

– Nose
– Palate
– Hypopharynx
Oral Cavity, Oropharynx, and Hypopharynx Anatomy

- Palate (hard and soft)
- Uvula
- Tonsils
- Lateral pharynx
- Tongue
- Mandible/dentition
- Hyoid bone
- Epiglottis
- Larynx
- Neck
Oral Cavity and Oropharynx—Physical Exam

Height, weight, neck circumference

Tonsil size
Palate and uvula thickness and length
--webbing

Surgical changes?
Oral Cavity and Oropharynx—Physical Exam

Lateral pharyngeal tissue character, redundancy

Tongue size

Modified Mallampati Position (tongue size relative to palate and “space” created by mandible and pharynx)

--Samsoon and Young’s (Anaesthesia 1987) modification of Mallampati position, with tongue protrusion
### Friedman Stage

<table>
<thead>
<tr>
<th>FS</th>
<th>Modified Mallampati</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></td>
<td>3, 4</td>
<td>3+, 4+</td>
</tr>
<tr>
<td>III</td>
<td>3, 4</td>
<td>0, 1+, 2+</td>
</tr>
<tr>
<td>IV</td>
<td>BMI ≥ 40</td>
<td></td>
</tr>
</tbody>
</table>
Oral Cavity and Oropharynx—Physical Exam

Mandible position

Gross assessment

Dentition

X-ray (lateral cephalogram)
Oral Cavity and Oropharynx—Physical Exam

Mandible position
--may be reflected in dentition

Angle Classification
Mesiobuccal cusp of maxillary first molar to buccal groove of mandibular first molar
Lateral Cephalogram

Standardized lateral X-ray of head and neck

Multiple bony and soft tissue measurements

- Posterior airway space, soft palate length, SNA and SNB angles, mandibular plane to hyoid

\[
\begin{align*}
SNA & : 82 \\
SNB & : 80 \\
PAS & : 11 \\
PNS-P & : 35 \\
MP-H & : 15
\end{align*}
\]
Lateral Cephalogram

Patients with normal BMI and OSA typically have abnormal lateral cephalogram
--decreased SNB
--narrow PAS
--high MP-H
Fiberoptic Examination

Nose

Pharynx

Adenoid size

Gross assessment of airway narrowing at palate/HP

--? grade view of laryngeal visualization (Cormack and Lehane Anesthesia 1984—laryngoscopy)

I = full view of VC; II = partial view (post comm)

III = epiglottis only; IV = no epiglottis view

Epiglottis position and character

Müller/Muller/Mueller maneuver?

Larynx
Müller Maneuver

Prepare patient with gentle deep inspiration and expiration

Forced inspiratory effort against closed mouth and nose at end-expiration

Endoscopic evaluation of airway at the levels of the palate and the hypopharynx

Ritter et al. 1999: No difference between upright and supine in awake patient
Fiberoptic Examination
Sites of Obstruction

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: inaccurate—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>
<td></td>
</tr>
</tbody>
</table>
Friedman Stage

Advantages

– Easy, low cost
– Associated with UPPP/tonsillectomy outcomes
  
<table>
<thead>
<tr>
<th>Stage</th>
<th>Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>81%</td>
</tr>
<tr>
<td>II</td>
<td>38%</td>
</tr>
<tr>
<td>III</td>
<td>8%</td>
</tr>
</tbody>
</table>

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

Advantages: easy, low cost, normative data available
IDs patients with less favorable outcomes after first-line procedures

Disadvantages
- Two-dimensional image
- Awake, upright, and static
- Does not ID involved structures and guide selection among first-line procedures
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:

– Unclear 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 treatments

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—further research
Identifying the Site(s): Natural Sleep Endoscopy

Fiberoptic scope to visualize airway as patient attempts to fall asleep naturally
– Borowiecki (1978) and Rojewski (1982)
Identifying the Site(s): Natural Sleep Endoscopy

Advantage: Dynamic assessment of sleeping patient
- Directly visualize location of obstruction and involved structures

Major disadvantages
- Difficult to fall asleep with fiberoptic scope held in place manually or otherwise secured externally (some movement of head relative to scope during sleep onset)
- Difficult to move scope without awakening (to visualize multiple potential regions of obstruction)
Identifying the Sites: Drug-Induced Sleep Endoscopy

Developed in UK in 1991

Used in several centers around the world but less commonly in U.S.

Fiberoptic endoscopy of sedated, sleeping patient
Goal: reproduce SDB seen on sleep study
Palate
Tongue
Epiglottis
Lateral Pharyngeal Walls
Drug-Induced Sleep Endoscopy

Advantages: Dynamic assessment of sleep
- Directly visualize location of obstruction and involved structures
- Validity: 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
Drug-Induced Sleep Endoscopy

Disadvantages

- Not easy: requires sedation, somewhat time-consuming
- Sedatives decrease muscle tone and decrease respiratory drive
  - May artificially worsen OSA and alter pattern of collapse
  - Hillman Anesthesiology 2009: genioglossus muscle tone under propofol sedation 10% of maximal wakefulness at transition to unconsciousness (lower than sleep onset and natural NREM in normals but likely higher than in natural REM)
  - Key is avoidance of oversedation (Eastwood 2005: decreases muscle tone)
  - Propofol has less decrease in respiratory drive
Drug-Induced Sleep Endoscopy: Ongoing Research at UCSF

- 200 studies completed
- Diversity of obstruction patterns—reassuring
- Inter-rater and test-retest reliability: moderate-substantial

Rodriguez-Bruno Oto-HNS 2009
Kezirian Archives OHNS (in press)
Drug-Induced Sleep Endoscopy: Future Directions

• Determining optimal selection of procedures
• Predicting and/or improving surgical outcomes (accuracy)

• Improving our understanding of the airway and changes after surgery
  – Possibly, greatest value with selected patients
    Questionable pattern of obstruction or after previous surgery
<table>
<thead>
<tr>
<th></th>
<th>PSG</th>
<th>FS</th>
<th>MM</th>
<th>LC</th>
<th>AA</th>
<th>SBT</th>
<th>CT/ MRI</th>
<th>PM</th>
<th>AR</th>
<th>FR</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Easy</strong></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+/-</td>
</tr>
<tr>
<td><strong>Low-cost</strong></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
<td>-</td>
<td>+/-</td>
<td>+/-</td>
<td>+/-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Dynamic</strong></td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>Asleep</strong></td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
## Site of Obstruction and Surgical Options

<table>
<thead>
<tr>
<th>Current</th>
<th>Future?</th>
</tr>
</thead>
<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></td>
<td>Maxillofacial</td>
</tr>
</tbody>
</table>
Structure-Based Approach for Procedure Selection?

| Palate/tonsil | UPPP ± Tonsillectomy |
| Tongue       | GA                   |
| Epiglottis   | Partial Glossectomy  |
| LPW          | Tongue RF            |
|              | Tongue Stabilization |
|              | Hyoid suspension     |
|              | ? (Hyoid, MAD/MMA)   |
Conclusions

Physical examination of the (nose and) pharynx characterizes patient anatomy in order to guide effective treatment.

Tools of physical examination are:
- Low tech: tongue depressor and light
- [Medium tech: lateral cephalogram]
- High tech: flexible fiberoptic endoscope
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.

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