





USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

## Drug-Induced Sleep Endoscopy to Identify Sites of Obstruction in Patients with OSA

**Eric J. Kezirian, MD, MPH**  
 Professor, Otolaryngology – Head & Neck Surgery  
 President, International Surgical Sleep Society

Sleep-Doctor.com  
 Eric.Kezirian@med.usc.edu

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

## Disclosures

Medical Advisory Board	ReVENT Medical
Medical Advisory Board	Pillar Palatal
Medical Advisory Board	Cognition Life Science
Research Funding	Inspire Medical Systems
Consultant	Nyxoah
Consultant	Split Rock Scientific
Intellectual Property Rights	Magnap
Consultant, IP Rights	Berendo Scientific
Consultant	Gerard Scientific

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

## Overview

- Techniques for identifying the sites of obstruction
- DISE and VOTE Classification
- Advantages and Disadvantages
- Association with treatment outcomes

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

## Goal of Evaluation

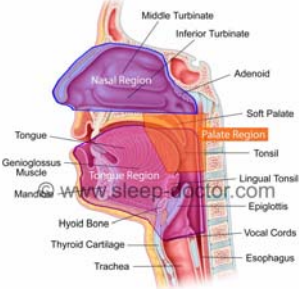
Characterize disorder to guide effective treatment

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

## Major sites of potential airway obstruction

- Nose
- Palate
- Hypopharynx



<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

## OSA surgery review (Sher et al. Sleep 1996)

- UPPP “successful” in 41% of all OSA patients
- 52% Fujita Type I
- 5% 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.”

<http://sleep-doctor.com/blog>

USC University of Southern California | USC Caruso Department of Otolaryngology Head and Neck Surgery

### Identifying the Sites: Ideal Test Characteristics

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

<http://sleep-doctor.com/blog>

USC University of Southern California | USC Caruso Department of Otolaryngology Head and Neck Surgery

### OSA Severity

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

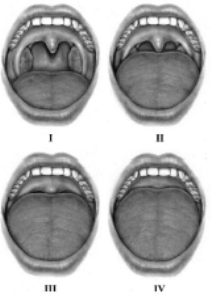
Mild-moderate OSA is most likely due to collapse at the level of the palate, whereas moderate to severe OSA most likely includes some component of hypopharyngeal collapse

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

<http://sleep-doctor.com/blog>

USC University of Southern California | USC Caruso Department of Otolaryngology Head and Neck Surgery

### Friedman Stage



FS	Modified Mallampati	Tonsils
I	1, 2	3+, 4+
II	1, 2	0, 1+, 2+
	3, 4	3+, 4+
III	3, 4	0, 1+, 2+
IV	BMI ≥ 40	

<http://sleep-doctor.com/blog>

USC University of Southern California | USC Caruso Department of Otolaryngology Head and Neck Surgery

### Friedman Stage

**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 (most)
- Does not identify involved structures other than palate/tonsils (to choose possible adjunctive procedures)
- Theoretical: not a dynamic assessment of sleeping patient

<http://sleep-doctor.com/blog>

USC University of Southern California | USC Caruso Department of Otolaryngology Head and Neck Surgery

### 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
- Li et al. 2003: MM associated with UPPP outcomes
- No information on selection of procedures

<http://sleep-doctor.com/blog>

USC University of Southern California | USC Caruso Department of Otolaryngology Head and Neck Surgery

### Imaging (CT, MRI, fluoroscopy)

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

Lee Laryngoscope 2012: sleep videofluoroscopy suggested multilevel obstruction common (45%; higher in severe OSA)

**Disadvantages**

- CT and MRI can be static (although cine-CT)
- Time-consuming and not inexpensive
- Specific equipment and technical assistance
- Radiation exposure (CT, fluoroscopy)
- ? association between static dimensions of airway and surgical outcomes—further research

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

**Identifying the Site(s): Natural Sleep Endoscopy**

Fiberoptic scope to visualize airway as patient attempts to fall asleep naturally  
 Borowiecki Laryngoscope 1978  
 Rojewski Laryngoscope 1982

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

**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)

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

**Identifying the Sites: Drug-Induced Sleep Endoscopy**

Developed in UK in 1991  
 Pringle MB, Croft CB. Clin Otolaryngol 1991;16:504-9.

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

VOTE Classification system (Kezirian, Hohenhorst, de Vries Eur Arch Oto 2011)  
 --some standardization and comparison of findings/outcomes across centers

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

**VOTE Classification**

Many different classifications described  
 Wide range of complexity  
*Palate and/or hypopharynx only*  
*Seven patterns of collapse described*

**Structure-based assessment**  
Structures are key to making individualized treatment decisions

Kezirian, Hohenhorst, de Vries Eur Arch ORL 2011  
 Hohenhorst, Ravesloot, Kezirian, de Vries Op Tech OHNS 2012

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

**VOTE: Structures Contributing to Obstruction**

- Nose/Nasopharynx
- Velum (palate, uvula, lateral velopharyngeal walls)
- Oropharyngeal lateral walls, tonsils
- Tongue base
- Epiglottis
- Larynx

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

**VOTE: Configuration of Obstruction**

- Anteroposterior
- Lateral
- Concentric

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery  
 USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

### VOTE Classification

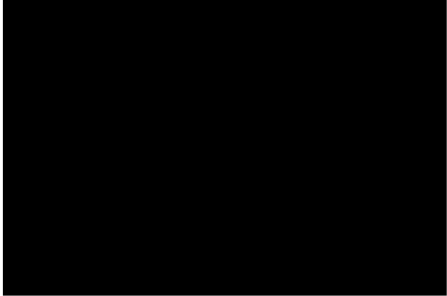
Degree of narrowing: qualitative assessment

0	No obstruction	No vibration
1	Partial obstruction	Vibration
2	Complete obstruction	Obstruction
X	Not visualized	

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery  
 USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

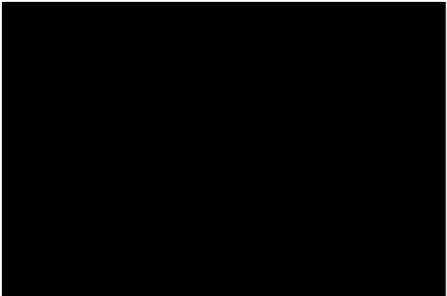
### Velum (Palate)



<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery  
 USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

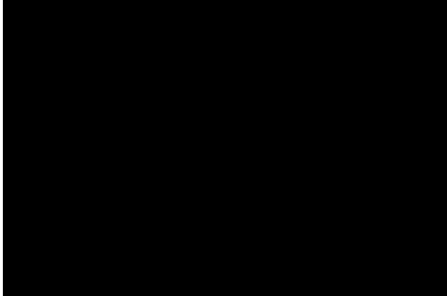
### Oropharyngeal Lateral Walls



<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery  
 USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

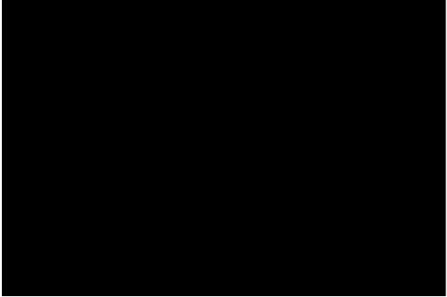
### Tongue



<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery  
 USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

### Epiglottis



<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery  
 USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

### DISE and Mouth Opening

53 years old Asian male  
 Body mass index 24.5  
 AHI 15 (AI 5)  
 LSAT 83%  
 0.1% sleep time below 90% saturation

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

## DISE and MAD/MRA

45 year old Caucasian non-Hispanic male  
 Body mass index 28.9  
 AHI 24 (AI 11)  
 LSAT 91%

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

## DISE and Transition to Unconsciousness

Propofol decreases upper airway (genioglossus) muscle tone (Eastwood Anesthesiology 2005)

Hillman 2009: genioglossus muscle tone under propofol sedation 10% of maximal wakefulness at transition to unconsciousness

Less than sleep onset in normals (Fogel J Physiol 2005) but higher than REM in normals and OSA (Eckert Chest 2009)

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

## Drug-Induced Sleep Endoscopy

Advantages: Dynamic assessment of “sleep”

- Directly visualize location of obstruction and involved structures
- Possible quantification of collapse (Borek Oto-HNS 2012)
- Vibration vs. obstruction (Hohenhorst AAO et al.)
- Valid: greater collapsibility in OSA vs. snorers (Steinhart Acta Otolaryngol 2000) and SDB vs. controls (Berry Laryngoscope 2005)
- Reliability: test-retest (Rodriguez-Bruno Oto-HNS 2009) and inter-rater (Kezirian Archives Oto-HNS 2010) moderate to good

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

## Drug-Induced Sleep Endoscopy

Advantages: Dynamic assessment of sleep

- Unique evaluation
  - Not correlated with Modified Mallampati Position (den Herder Laryngoscope 2005) or lateral cephalogram (George Laryngoscope 2012)
- Correlated with outcomes after:
  - Palate surgery (Iwanaga Acta Otolaryngol Suppl 2003, Hessel Clin Otolaryngol All Sci 2004)
  - Single and multilevel surgery (Soares Laryngoscope 2012; Koutsourelakis Oto-HNS 2012)
  - Hypoglossal nerve stimulation (Vanderveken JCSM 2013)
  - MAD (Johal Eur J Orthodont 2005, Johal J Laryngol Otol 2007)

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

## Drug-Induced Sleep Endoscopy

Advantages: Dynamic assessment of “sleep”

- “Hypopharynx” contains oropharyngeal lateral walls, tongue, and epiglottis
  - Can identify involved structures more precisely and potentially direct surgical treatment
  - General sense that oropharyngeal lateral wall collapse does not respond as well to surgery; Soares Laryngoscope 2012
  - Epiglottic contribution not detected by other evaluations
- ISSS retrospective cohort study ongoing

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

## DISE Research

Insight into surgical nonresponse (multiple mechanisms)

Kezirian Laryngoscope 2011

VOTE

Velum common (in nonresponders) after UPPP

Interaction of VOTE structures

Mouth opening

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

### 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
  - Key is avoidance of oversedation (Eastwood Anesthesiology 2005: decreased muscle tone)
  - Propofol has less decrease in respiratory drive

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

### Drug-Induced Sleep Endoscopy: Future Directions

Determining optimal selection of procedures  
Predicting and/or improving surgical outcomes (accuracy)—ISSS collaboration

Improving our understanding of the airway and changes after surgery

- Possibly, greatest value with selected patients
- Questionable pattern of obstruction
- Previous surgery with persistent OSA

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

	PS G	FS	MM	LC	AA	SBT	CT/MRI	PM	AR	FR	SE
Easy	+	+	+	+	+	-	-	-	+	-	+/-
Low-cost	+	+	+	+	+	+/-	-	+/-	+/-	+/-	-
Dynamic	+	-	+	-	+	+	+	+	+	+	+
Asleep	+	-	-	-	+	+	+/-	+	-	+	+
Accurate	-	+/-	-	?	-	?	?	-	?	?	+/-

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

### Site of Obstruction and Surgical Options

Past/Current	Current/Future?
Palate/Tonsils	Velum
Hypopharynx/Retrolingual	Oro Lat Walls
Maxillofacial	Tongue
	Epiglottis
	Maxillofacial

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

### Structure-Based Approach for Procedure Selection?

Velum/Palate	Palate surgery
Oro Lat Walls	? (Lateral pharyngoplasty, ESP, hyoid suspension, MAD/MMA)
Tongue	GA Partial Glossectomy Tongue RF Tongue Stabilization
Epiglottis	Upper Airway Stimulation (multilevel) ? Hyoid suspension Partial epiglottectomy

<http://sleep-doctor.com/blog>

USC University of Southern California USC Caruso Department of Otolaryngology Head and Neck Surgery

### 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

<http://sleep-doctor.com/blog>