SLEEP AND AIRWAY

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Disclosures

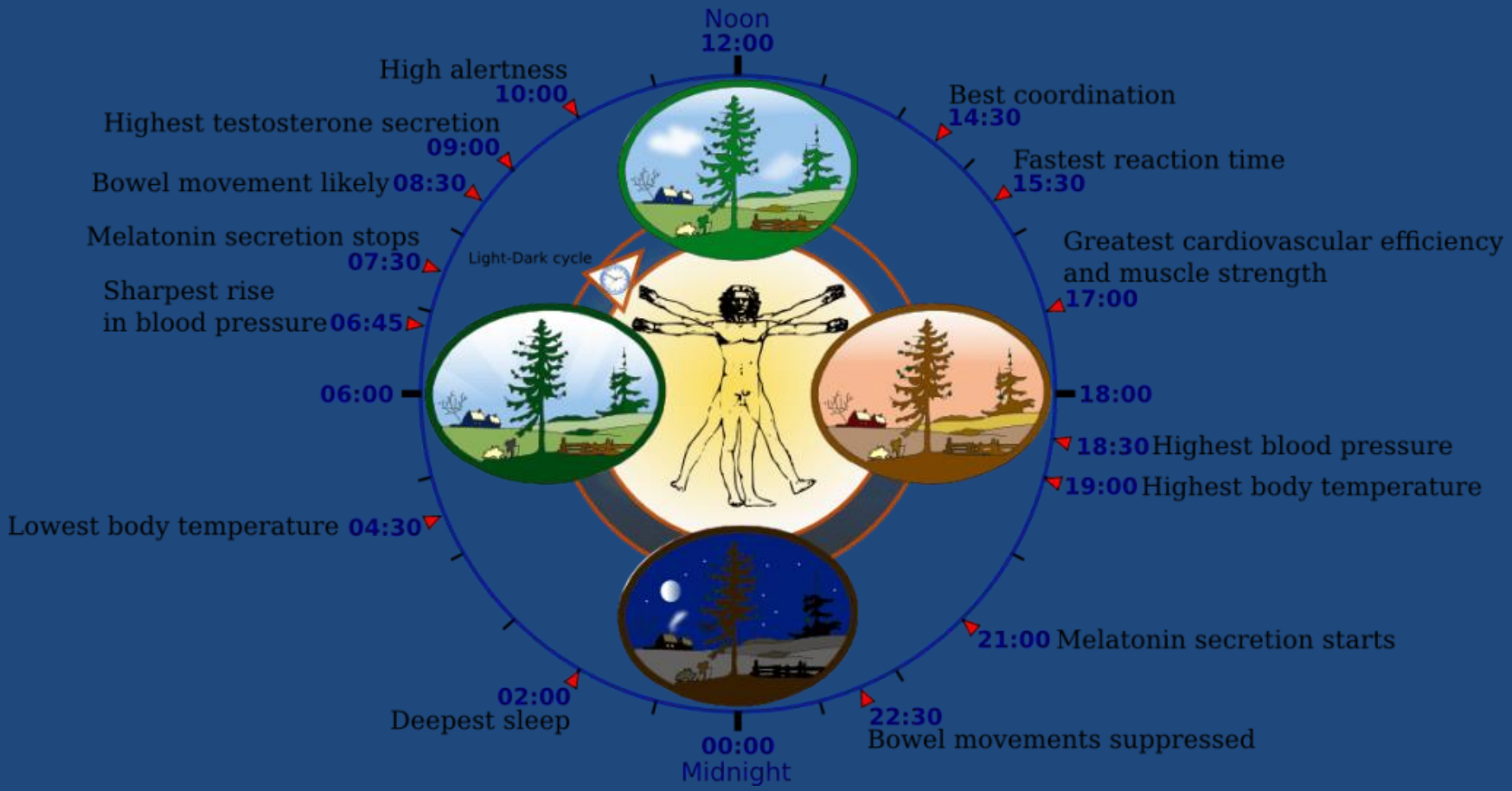
I do not have any financial affiliations or sponsorships for my presentations in this conference

Sleep- Definition

Sleep is a biological imperative critical to the maintenance of mental and physical health. It is a state of lessened consciousness and decreased physical activity during which the organism slows down and repairs itself. The sleep cycle involves two distinct phases that alternate cyclically from light sleep to deep then deeper and deepest sleep throughout the sleep period. There are two main phases of sleep.

- rapid eye movement (REM) sleep, during which dreaming occurs
- non-rapid eye movement (NREM) or slow-wave sleep (SWS)

Sleep and Circadian Rhythms



Functions of Sleep

- Adaptive Response
- Restoration and Repair
- Adjusting Metabolic Needs
- Avoids Bad Things in the Environment

Sleep Hygiene Tips

- Maintain a regular Sleep Routine
- Avoid naps if possible
- Don't stay awake in bed for more than 10 minutes
- Don't watch TV or read in bed
- Drink caffeinated drinks with caution and well before bed time
- Avoid inappropriate substances that interfere with sleep
- Exercise regularly
- Have a quiet comfortable bedroom
- If you are a clock watcher at night, hide the clock
- Have a comfortable pre-bedtime routine

Healthy Sleep Duration

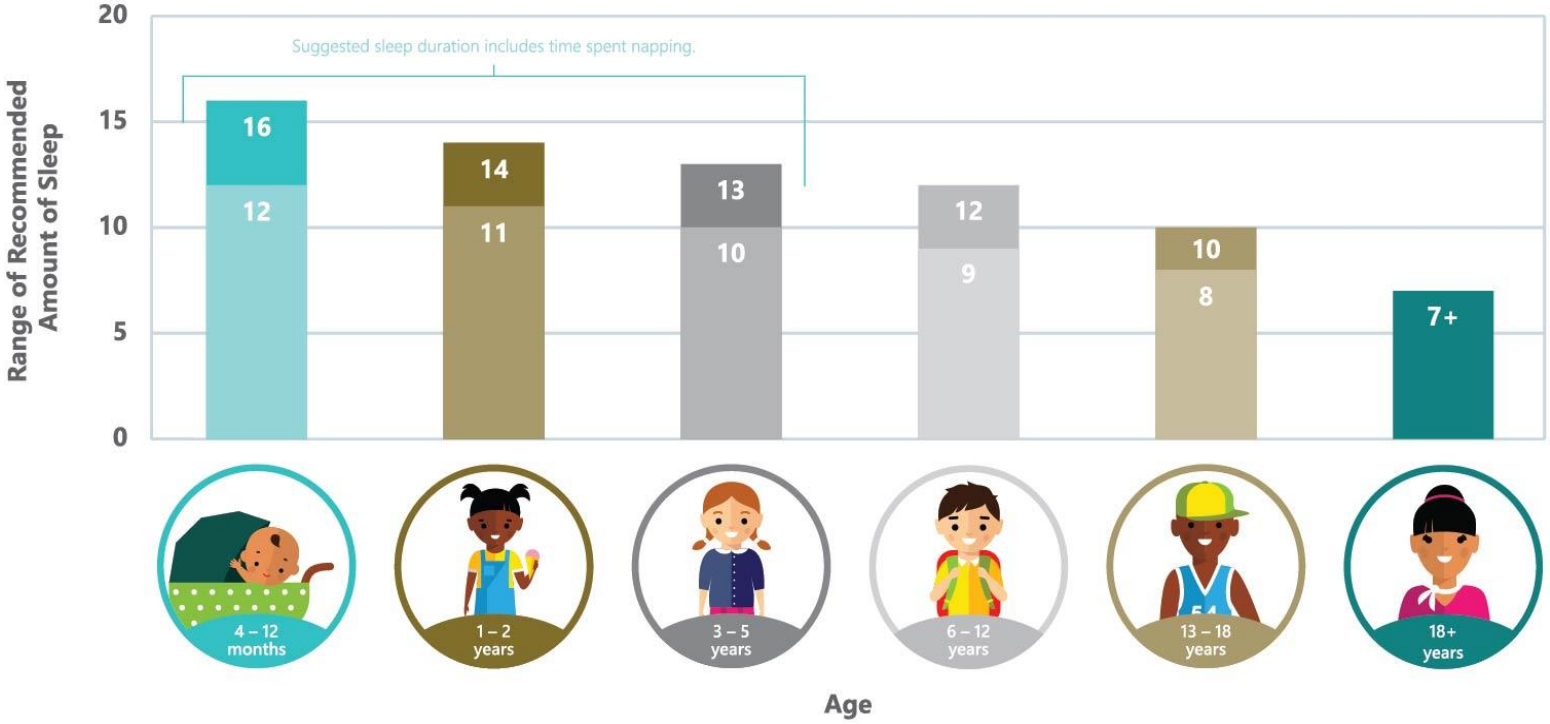
Napolean Bonaparte when asked how many hours of sleep people need, he is said to have replied:

"Six for a man, Seven for a woman and Eight for a fool."

Margaret Thatcher- 4 hours

Healthy Sleep Duration

The American Academy of Sleep Medicine recommends that you get the following hours of sleep on a regular basis for optimal health at each stage of life.



SleepEducation.org

A sleep health information resource by the American Academy of Sleep Medicine

Your Relationship with Sleep- Sleep Survey

University of Michigan

- I need an alarm clock to wake up at an appropriate time
- It's a struggle for me to get out of bed in the morning
- Weekday mornings I hit snooze button several times to get more sleep
- I feel tired, irritable, and stress out during the week
- I have trouble concentrating and remembering
- I feel slow with critical thinking, problem solving and being creative
- I often fall asleep watching TV
- I often fall asleep in meetings, lectures or in warm rooms
- I often fall asleep after heavy meals or after a low dose of alcohol
- I often fall asleep while relaxing after dinner
- I often fall asleep within five minutes of getting into bed
- I often feel drowsy while driving
- I often sleep extra hours on weekend mornings
- I often need a nap to get through the day
- I have dark circles around my eyes

Stages of Sleep

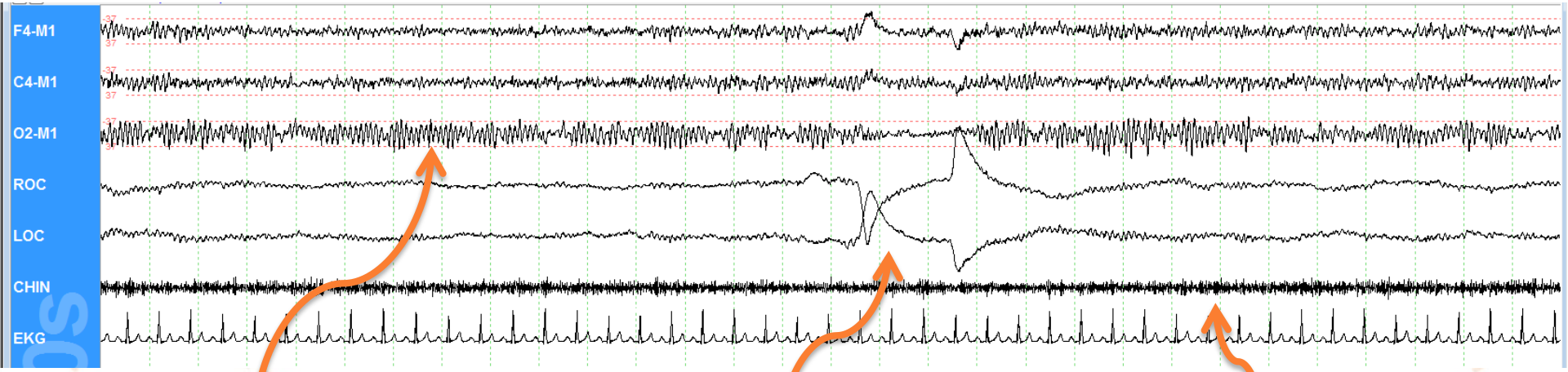
EEG (Electroencephalogram) Patterns Define Sleep

- Stage W (Wakefulness)
- Stage N1 (NREM 1 Sleep)
- Stage N2 (NREM 2 Sleep)
- Stage N3 (NREM 3 Sleep or Slow Wave-formerly Stages 3 and 4)
- Stage R (REM Sleep)

AASM Manual for the Scoring of Sleep and Associated Events

Stage W

More than 50% of epoch consists of alpha (8-13 Hz) activity



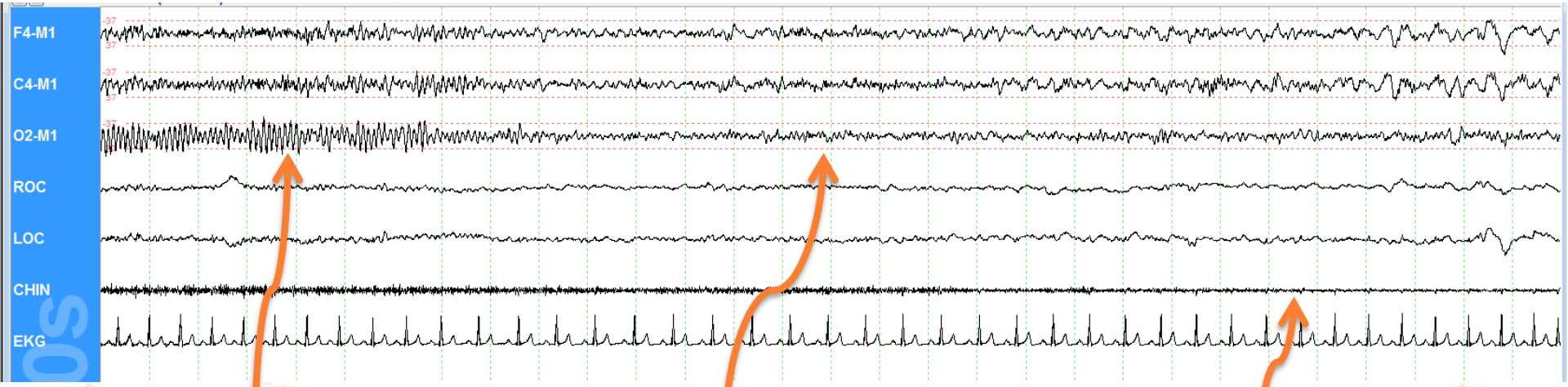
Alpha rhythm EEG

Eyes open and close

High chin EMG tone

Stage N1

Less than 50% of epoch contains alpha



Alpha rhythm EEG

Mixed frequency EEG

Lower chin EMG tone

Stage N2

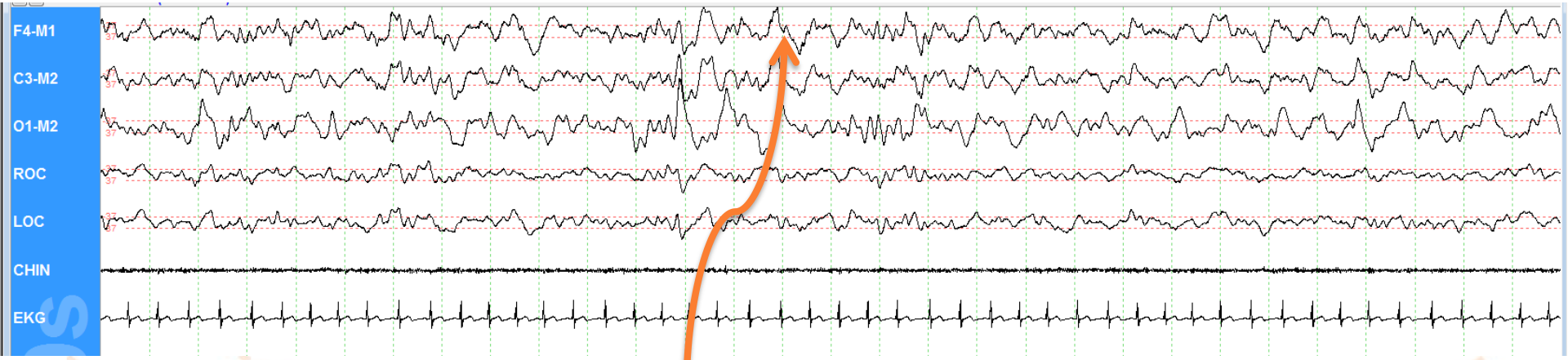
Appearance of sleep spindles and K complexes

K complex

Sleep spindle

Stage N3-Slow Wave Sleep

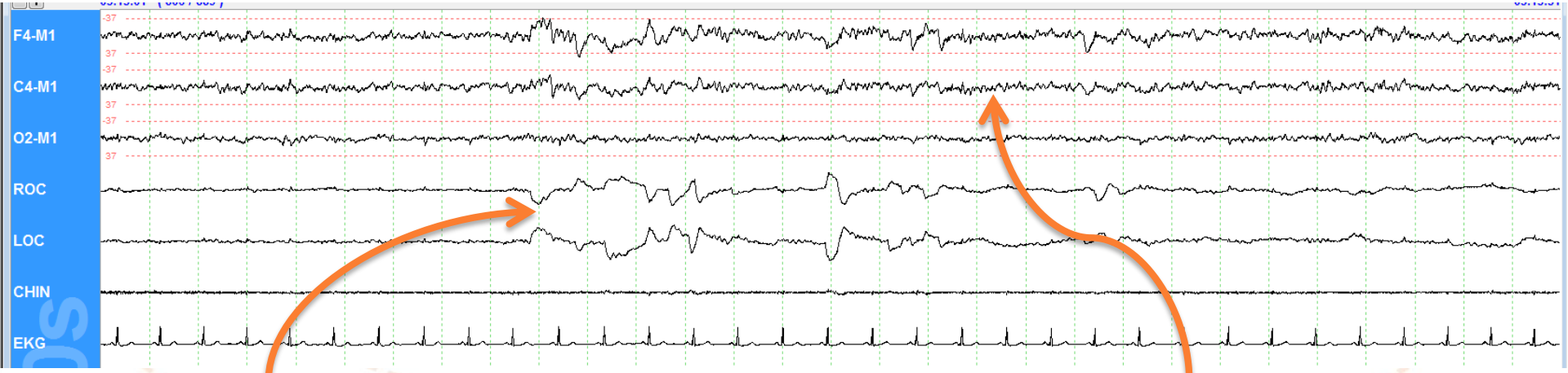
Slow wave activity for more than 20% of epoch



Slow wave activity

Stage R (REM Sleep)

Low amplitude, mixed frequency EEG
Rapid eye movements
Low chin EMG tone
Transient muscle activity (phasic twitches) common



Rapid Eye Movements

Mixed frequency EEG

Sleep-Wake Transition: Physiological Changes

Decreased:

- Minute ventilation
- Heart rate
- Cerebral blood flow
- Muscle tone

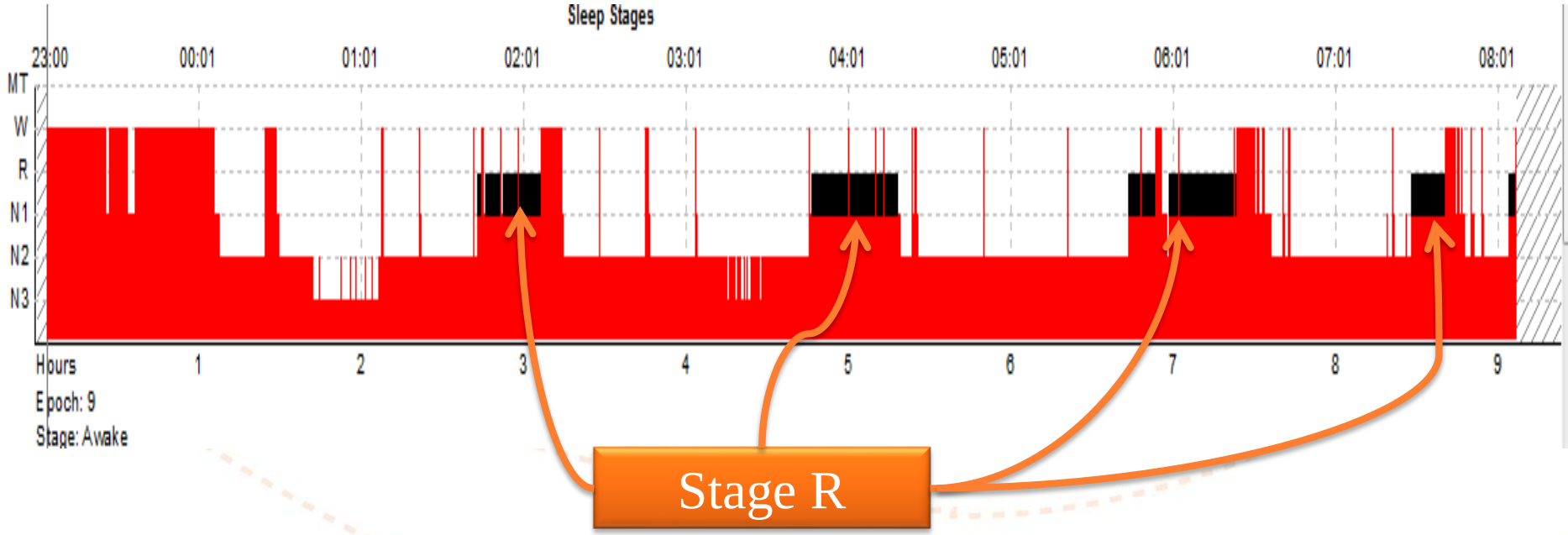
Increased upper airway resistance

Sleep Architecture: Young Adult

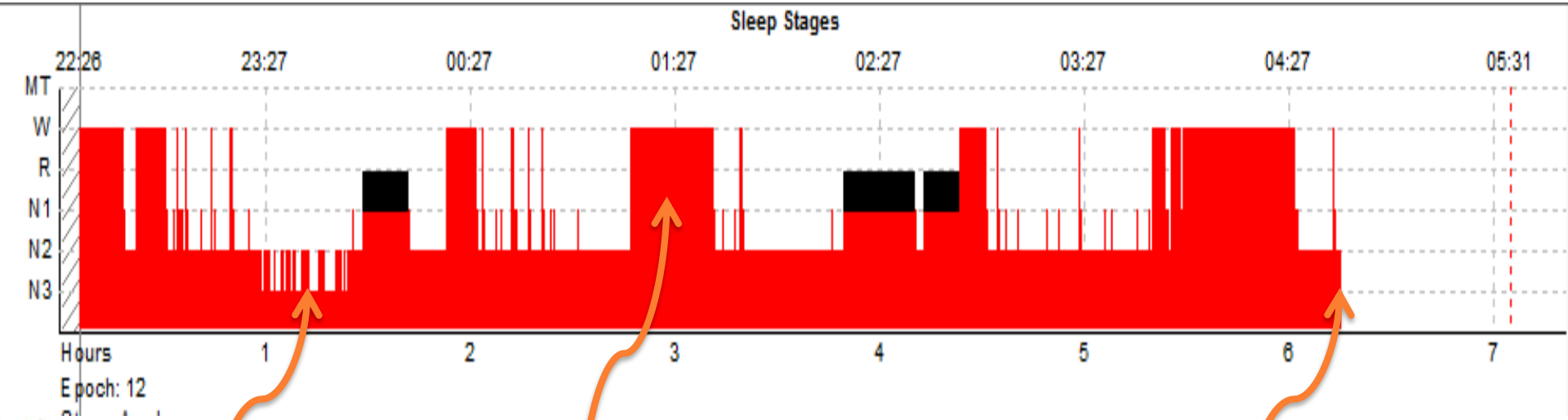
Enter sleep through N1 (usually)

Stage R occurs after ~ 80 minutes

Cycle repeats itself every 90 minutes, 4-6 times/night



Sleep Architecture: Older Adult



Reduced stage N3 sleep

Middle of the night awakenings

Early morning awakening

Summary

- Adequate sleep is essential to maintain physiological, mental and emotional health.
- The stages of sleep are characterized by well-defined physiological changes.
- Sleep related breathing disorders are the most common sleep disorders.

Breathing Abnormalities During Sleep

- Apneas
  - Obstructive apnea
  - Mixed apnea
  - Central apnea
- Hypopneas
- Respiratory Effort Related Arousals (RERAs)
- Snoring
- Hypoventilation

AASM Manual for the Scoring of Sleep and Associated Events

Definition: Apnea and Hypopnea

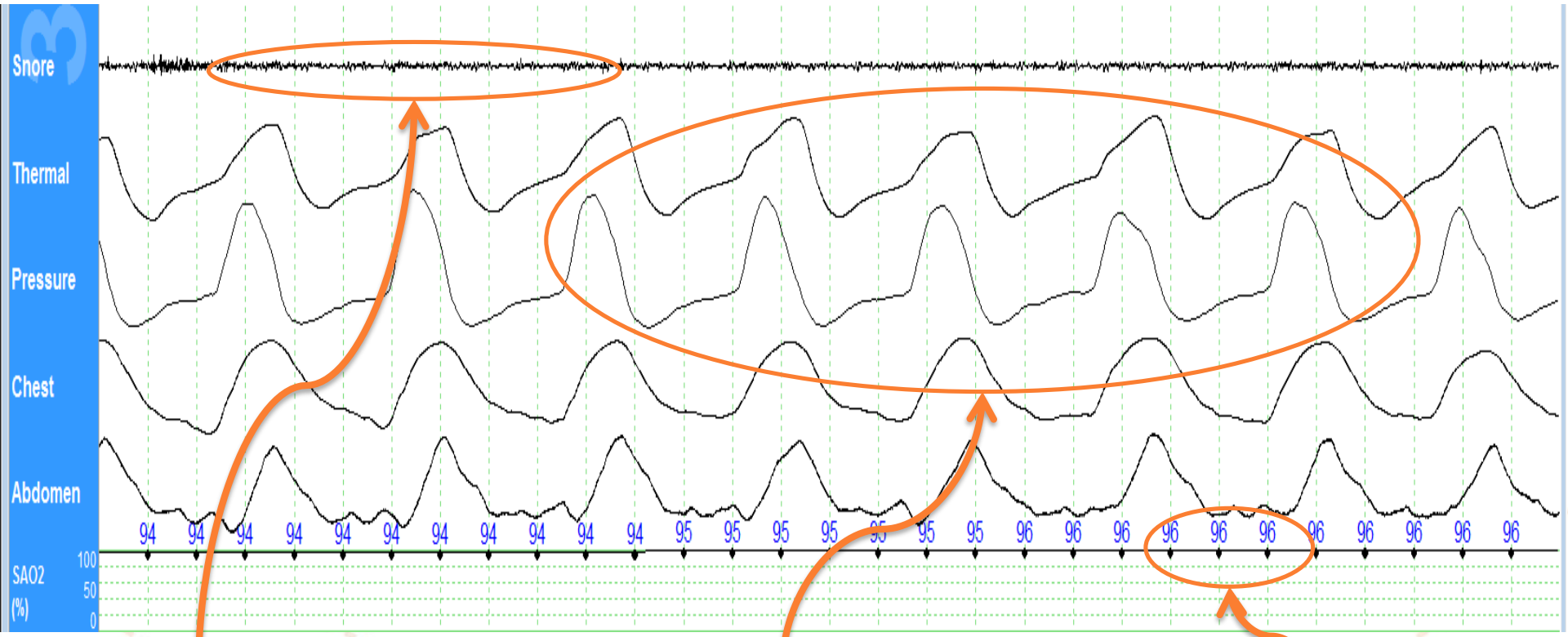
Apnea

- Temporary cessation of airflow that lasts for 10 seconds or longer.
- Can be obstructive, central and mixed

Hypopnea

- Definition is variable
- The American Academy of Sleep Medicine and the Centers for Medicare and Medicaid Services define hypopnea as "airflow reduction of at least 30% that lasts for 10 seconds or longer and results in at least 4% oxygen desaturation".

Normal Breathing

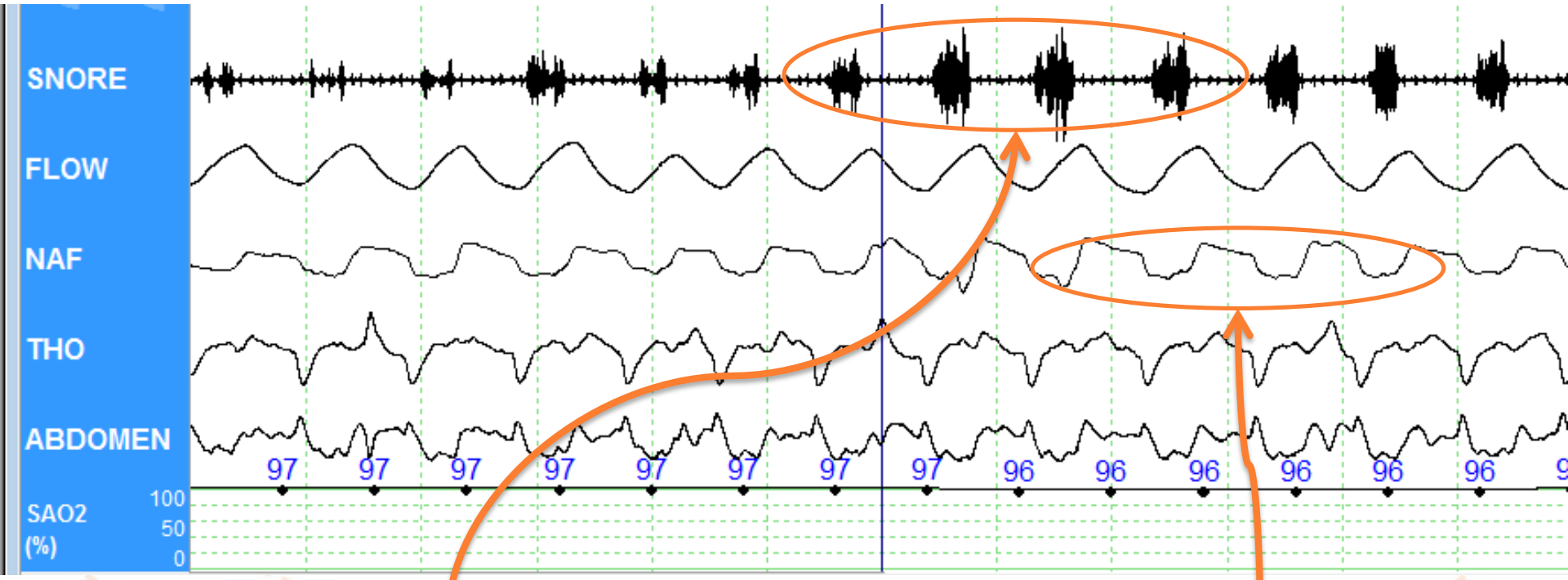


There is no snoring

Breathing is at the same rate throughout the tracing and has consistent waveforms

Oxygen saturation is normal at 96% and does not change

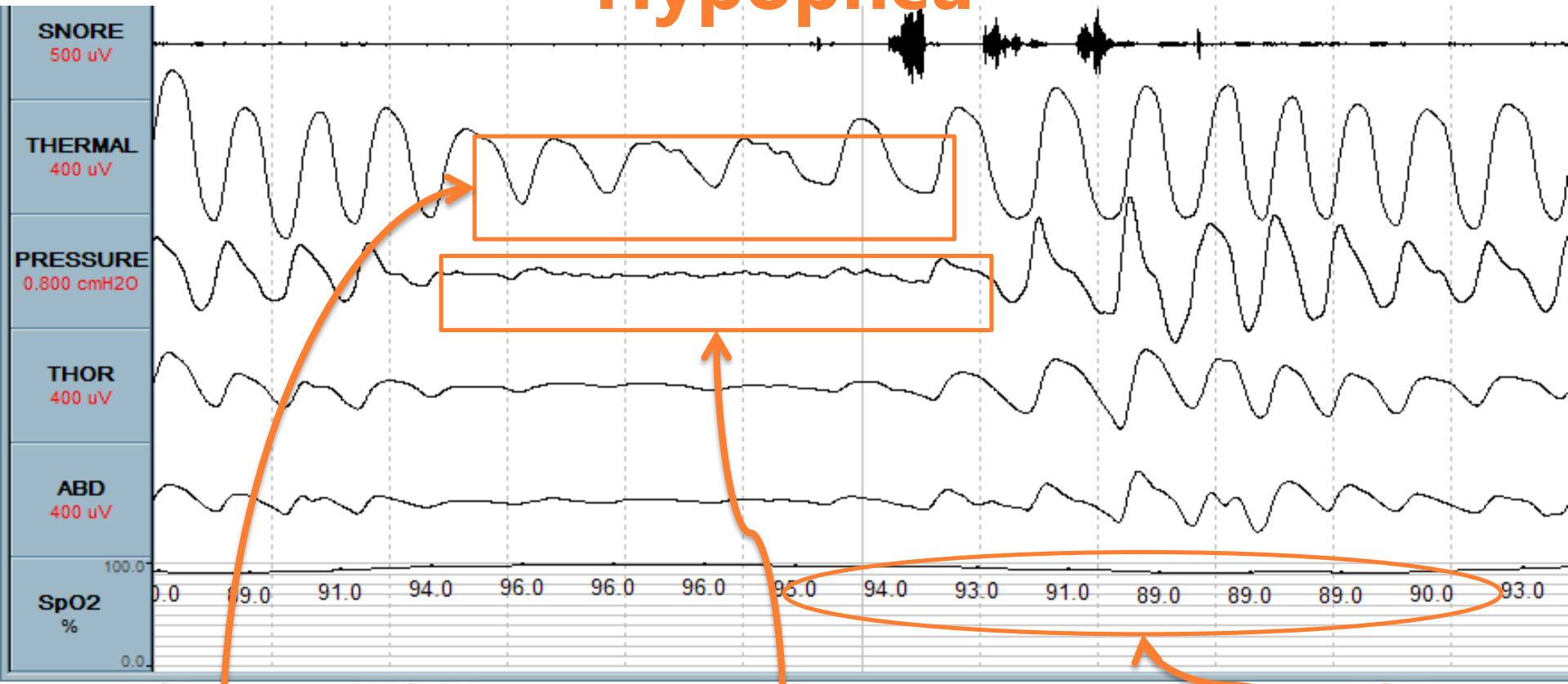
Snoring



Loud snoring is recorded by the microphone. It occurs at the same rate as breathing.

The waveform of the nasal pressure signal is flattened at the top. This is an indication that air flow has been limited.

Hypopnea

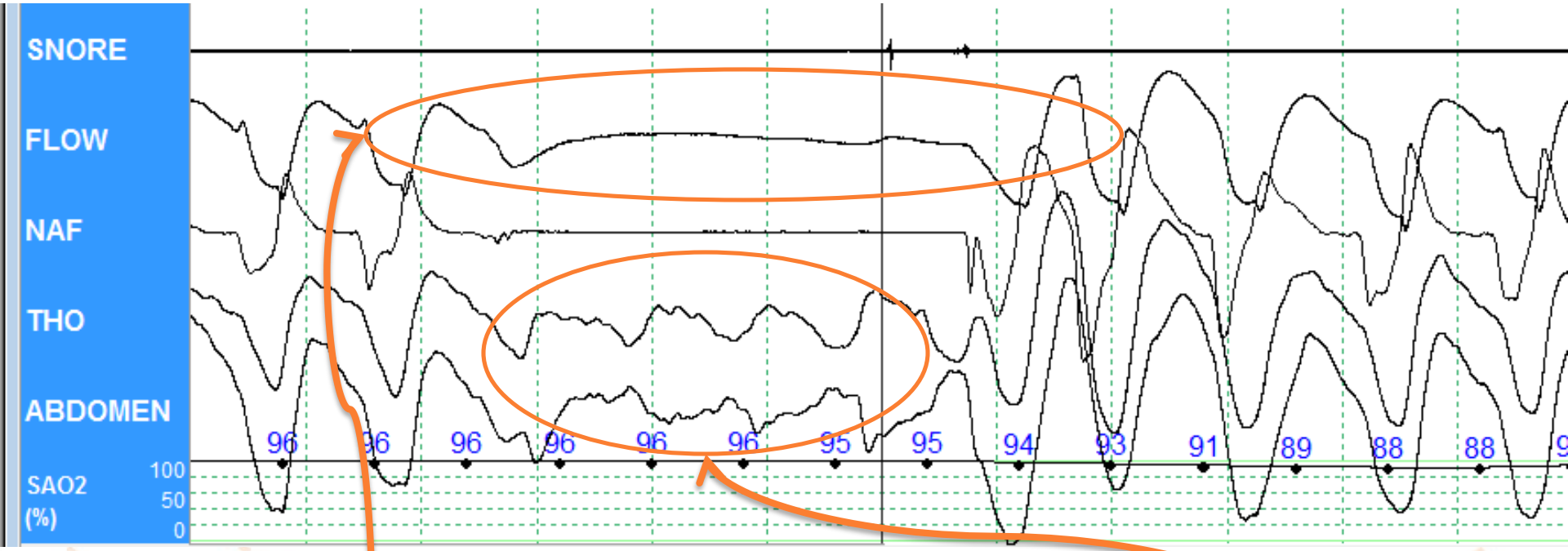


The thermal signal is not reduced by 90% or more

The nasal pressure signal is reduced by more than 30%

Oxygen desaturation from 96% to 89% occurs with this event.

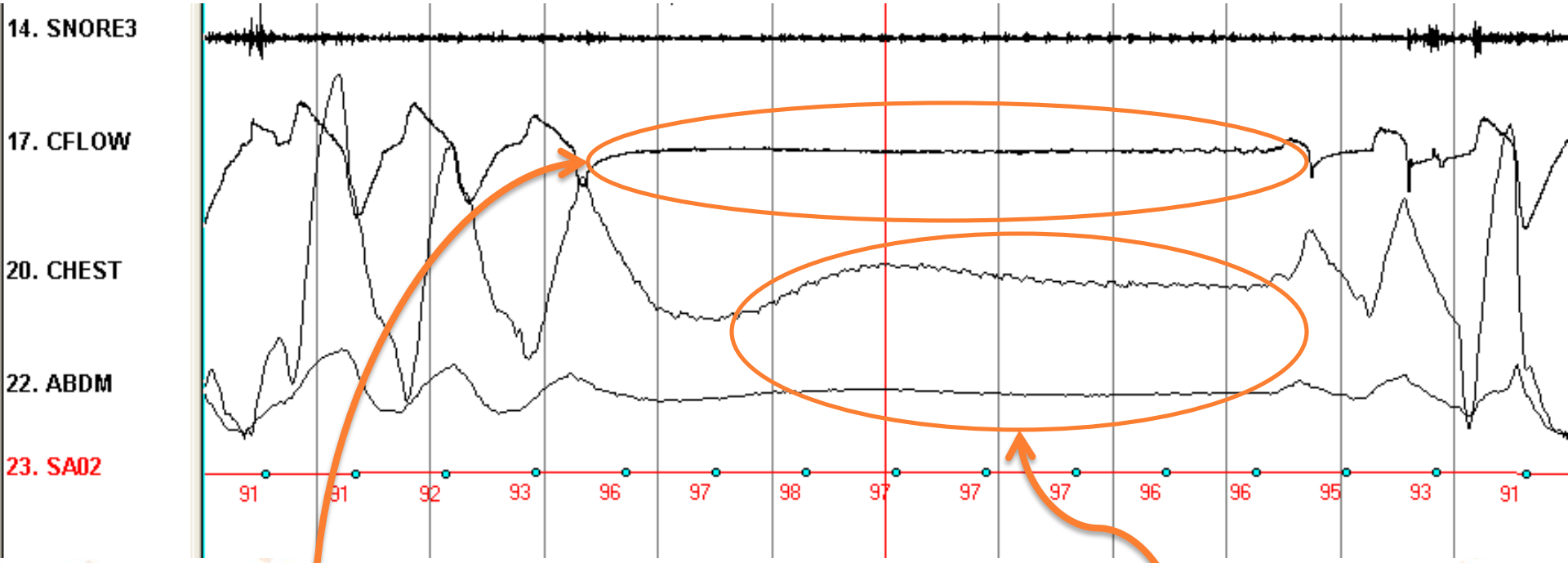
Obstructive Apnea



Airflow stops for more than 10 seconds

The chest and abdomen continue to move up and down throughout this event. It is an obstructive apnea.

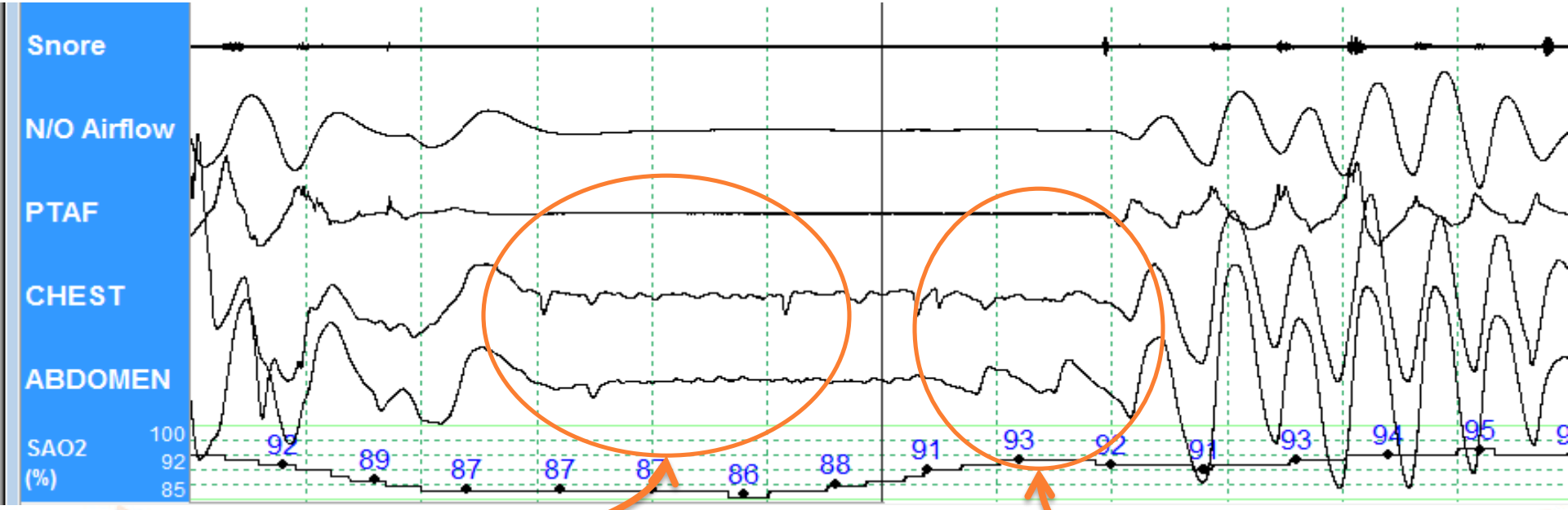
Central Apnea (Patient on CPAP)



Event has no air flow as measured by CPAP flow output

No respiratory effort is seen

Mixed Apnea

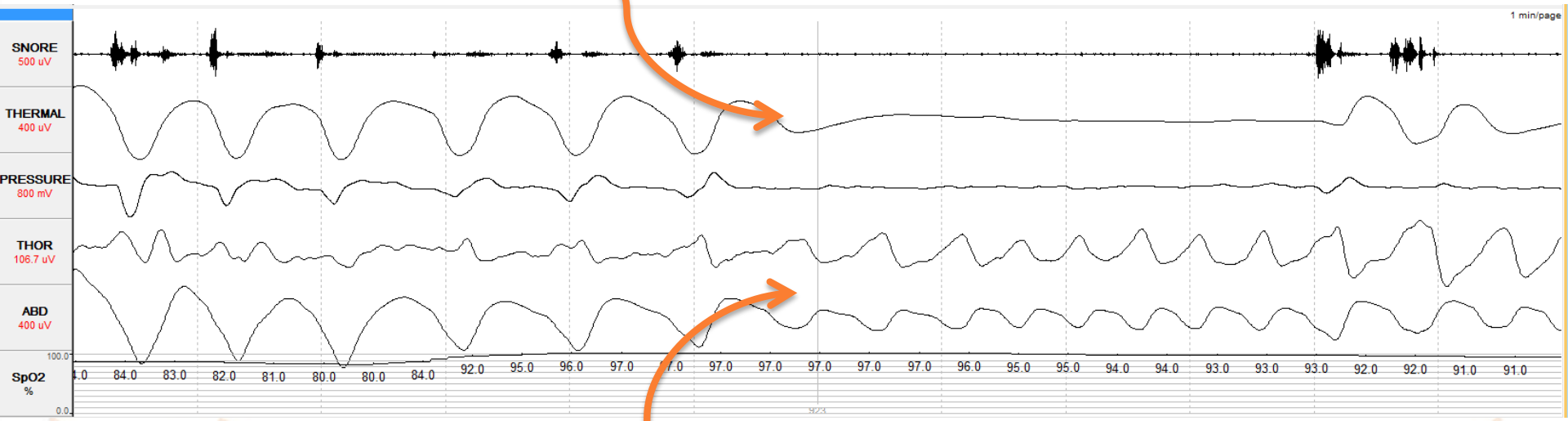


This portion of the event has no respiratory effort

Respiratory effort is seen in the last portion of the event

Obstructive Sleep Apnea Diagnosis

Absent Air Flow



Continued Respiratory Effort

The Fundamentals of Sleep and Obstructive Sleep Apnea

Event Type

Normal Breathing
Breaths are characterized by a semi-sinusoidal wave-like pattern. Transitions from inspiration to expiration, and vice versa, are rounded and smooth.

Flow Limitation
The rounded inspiratory portion of the breath starts to flatten.

Obstructive Hypopnea
A reduction in airflow of ≥ 50% of baseline with a 3% desaturation **OR** a reduction in airflow of ≥ 30% with a 4% desaturation **AND** lasting for at least 10 seconds.*

Obstructive Apnea
A reduction in airflow of ≥ 90% of baseline lasting for at least 10 seconds.*

Airway Cross-section

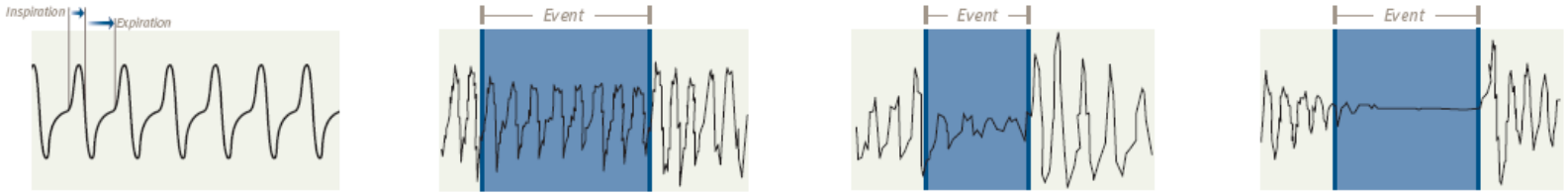
Flow Through Airway

No obstruction	Partially obstructed airway	Increasingly obstructed airway	Completely obstructed airway

Inspiratory Flow Shape

Semi-sinusoidal – unobstructed flow	Flattening & reduced flow	Flattening & *further* reduced flow	Flat – minimal or zero flow

Flow Tracing



*Iber et al., The AASM Manual for the scoring of sleep and associated events: Rules, Terminology and Technical Specifications, 1st ed.: Westchester, Illinois: American Academy of Sleep Medicine, 2007.

Fisher & Paykel HEALTHCARE

OSA: Symptoms

- Snoring
- Witnessed apneas
- Choking arousals
- Gasping arousals
- Frequent nocturnal awakening
- Unrefreshing sleep
- Excessive daytime sleepiness
- Motor vehicle accidents (increased 10-fold)

OSA Severity

OSA severity is defined as:

Mild for RDI $\geq$ 5 and < 15

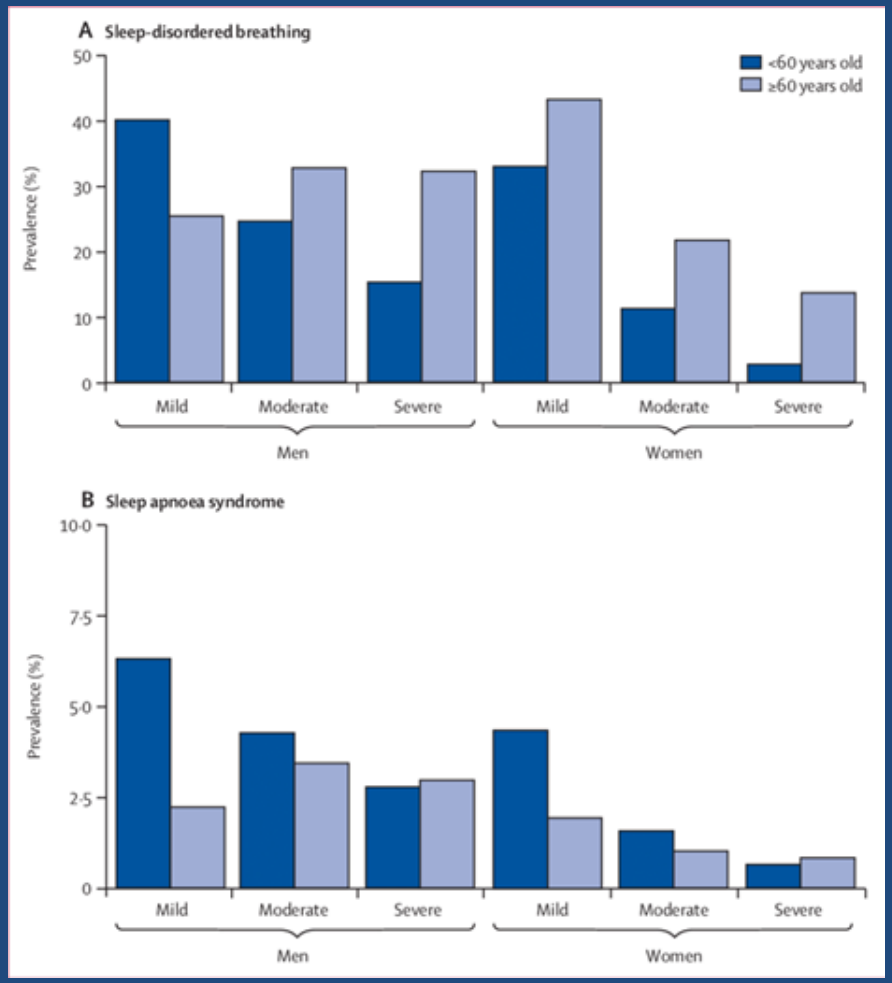
Moderate for RDI $\geq$ 15 and $\leq$ 30

Severe for RDI > 30/hr

RDI= apneas, hypopneas or RERAs per hour of sleep

Epstein LJ; Kristo D; Strollo PJ; Friedman N; Malhotra A; Patil SP; Ramar K; Rogers R; Schwab RJ; Weaver EM; Weinstein MD. Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. *J Clin Sleep Med 2009;5(3):263-* 276.

Prevalence of SDB/ OSA



Prevalence of sleep-disordered breathing in the general population: THE HypnoLaus study

Diagnosis of OSA

- **Patient Complaints and Symptoms**- Questionnaires
- **Medical History-** Underlying Preexisting Medical Conditions
- **Physical Examination-** Role of Dental Team
- **Home Sleep Testing**- At home portable monitor to measure airflow, breathing patterns and blood oxygen levels, and possibly limb movements and snoring intensity
- **Polysomnography**- in Sleep Lab where you are hooked to equipment that monitors your heart, lung and brain activity, breathing patterns, arm and leg movements, and blood oxygen levels while you sleep.

Sleep Questionnaires

- Epworth Sleepiness Scale
- STOP-BANG Questionnaire
- Berlin Questionnaire
- Bed Partner Survey

Epworth Sleepiness Scale

Name: _____

Date: _____

Your age: (Yr) _____ **Your sex:** ❑ Male ❑ Female

How likely are you to doze off or fall asleep in the situations described below, in contrast to feeling just tired?

This refers to your usual way of life in recent times.

Even if you haven't done some of these things recently try to work out how they would have affected you.

Use the following scale to choose the most appropriate number for each situation:-

0 = would never doze
1 = Slight chance of dozing
2 = Moderate chance of dozing
3 = High chance of dozing

Situation	Chance of dozing
Sitting and reading	
Watching TV	
Sitting, inactive in a public place (e.g. a theatre or a meeting)	
As a passenger in a car for an hour without a break	
Lying down to rest in the afternoon when circumstances permit	
Sitting and talking to someone	
Sitting quietly after a lunch without alcohol	
In a car, while stopped for a few minutes in the traffic	
Total	

Score:	
0-10	Normal range
10-12	Borderline
12-24	Abnormal

STOP-BANG

These four, yes or no "STOP" questions can help you determine your risk:

S: Do you snore **loudly** (louder than talking or loud enough to be heard through closed doors)?

T: Do you often feel **tired**, fatigued or sleepy during the day?

O: Has anyone **observed** you not breathing during sleep?

P: Do you have or have you been treated for high blood **pressure**?

You have a high risk of sleep apnea if you answered "yes" to two or more of these questions.

The questionnaire has an even higher predictive value when you answer four more questions from the "STOP-Bang" version:

B: Is your **Body Mass Index** more than 35 kg/m2?

A: Is your **age** more than 50 years old?

N: Is your **neck** circumference greater than 40 cm?

G: Is your **gender** male?

You have a high risk of sleep apnea if you answered "yes" to three or more of the eight STOP-Bang questions.

Berlin Questionnaire

BERLIN QUESTIONNAIRE

Height (m) _____ Weight (kg)_____ Age_____ Male / Female

Please choose the correct response to each question.

CATEGORY 1

1. **Do you snore?**
   - ☐ a. Yes
   - ☐ b. No
   - ☐ c. Don't know

If you snore:

2. **Your snoring is:**
   - ☐ a. Slightly louder than breathing
   - ☐ b. As loud as talking
   - ☐ c. Louder than talking
   - ☐ d. Very loud – can be heard in adjacent rooms

3. **How often do you snore**
   - ☐ a. Nearly every day
   - ☐ b. 3-4 times a week
   - ☐ c. 1-2 times a week
   - ☐ d. 1-2 times a month
   - ☐ e. Never or nearly never

4. **Has your snoring ever bothered other people?**
   - ☐ a. Yes
   - ☐ b. No
   - ☐ c. Don't Know

5. **Has anyone noticed that you quit breathing during your sleep?**
   - ☐ a. Nearly every day
   - ☐ b. 3-4 times a week
   - ☐ c. 1-2 times a week
   - ☐ d. 1-2 times a month
   - ☐ e. Never or nearly never

CATEGORY 2

6. **How often do you feel tired or fatigued after your sleep?**
   - ☐ a. Nearly every day
   - ☐ b. 3-4 times a week
   - ☐ c. 1-2 times a week
   - ☐ d. 1-2 times a month
   - ☐ e. Never or nearly never

7. **During your waking time, do you feel tired, fatigued or not up to par?**
   - ☐ a. Nearly every day
   - ☐ b. 3-4 times a week
   - ☐ c. 1-2 times a week
   - ☐ d. 1-2 times a month
   - ☐ e. Never or nearly never

8. **Have you ever nodded off or fallen asleep while driving a vehicle?**
   - ☐ a. Yes
   - ☐ b. No

If yes:

9. **How often does this occur?**
   - ☐ a. Nearly every day
   - ☐ b. 3-4 times a week
   - ☐ c. 1-2 times a week
   - ☐ d. 1-2 times a month
   - ☐ e. Never or nearly never

CATEGORY 3

10. **Do you have high blood pressure?**
    - ☐ Yes
    - ☐ No
    - ☐ Don't know

Scoring Berlin Questionnaire

The questionnaire consists of 3 categories related to the risk of having sleep apnea. Patients can be classified into High Risk or Low Risk based on their responses to the individual items and their overall scores in the symptom categories.
Categories and Scoring:

Category 1: items 1, 2, 3, 4, and 5;
Item 1: if 'Yes', assign 1 point
Item 2: if 'c' or 'd' is the response, assign 1 point
Item 3: if 'a' or 'b' is the response, assign 1 point
Item 4: if 'a' is the response, assign 1 point
Item 5: if 'a' or 'b' is the response, assign 2 points
Add points. Category 1 is positive if the total score is 2 or more points.

Category 2: items 6, 7, 8 (item 9 should be noted separately).
Item 6: if 'a' or 'b' is the response, assign 1 point
Item 7: if 'a' or 'b' is the response, assign 1 point
Item 8: if 'a' is the response, assign 1 point
Add points. Category 2 is positive if the total score is 2 or more points.

Category 3 is positive if the answer to item 10 is 'Yes' or if the BMI of the patient is greater than 30kg/m2.
(BMI is defined as weight (kg) divided by height (m) squared, i.e.., kg/m2).

High Risk: if there are 2 or more categories where the score is positive.

Low Risk: if there is only 1 or no categories where the score is positive.

Additional Question: item 9 should be noted separately.

Bed Partner Survey

BED PARTNER SURVEY

GIVE TO BED PARTNER

To help us with a proper diagnosis and appropriate treatment plan, have your bed partner, if applicable and available, fill out this questionnaire regarding YOUR sleep habits. This information is vitally important for Dr. Sullivan to best evaluate your current condition.

TO BE FILLED OUT BY THE PATIENT'S BED PARTNER

Patient's Name _____

1. YES NO Do you witness the patient snoring?_____
2. YES NO Do you witness the patient choking or gasping for breath during sleep?
3. YES NO Does the patient pause or stop breathing during sleep?_____
4. YES NO Does the patient fall asleep easily, if given the opportunity, during the day (normal wakeful hours)?_____
5. YES NO Do you witness the patient clenching and/or grinding his/her teeth during sleep?
6. YES NO Does the patient appear refreshed upon waking?_____
7. YES NO Do the patient's sleep habits disturb your sleep?_____
8. YES NO Does the patient sit up in bed, not awake?_____
9. Please check those sleep habits of the patient that are disturbing to you:

- ☐ Snores
- ☐ Restless
- ☐ Wakes up often
- ☐ Loud gasping for breath while sleeping
- ☐ Stops breathing
- ☐ Grinds teeth
- ☐ Becoming very rigid or shaking
- ☐ Biting tongue
- ☐ Kicking during sleep
- ☐ Head rocking or banging
- ☐ Bed-wetting
- ☐ Sleepwalking
- ☐ Sleep talking

☐ Other_____

Comments:_____

OVER

Medical History

Review medical history for possible links and comorbidities

Patients at High Risk for OSA Who Should Be Evaluated for OSA Symptoms

- Obesity (BMI > 35)
- Congestive heart failure
- Atrial fibrillation
- Treatment refractory hypertension
- Type 2 diabetes
- Nocturnal dysrhythmias
- Stroke
- Pulmonary hypertension
- High-risk driving populations
- Preoperative for bariatric surgery

Epstein LJ; Kristo D; Strollo PJ; Friedman N; Malhotra A; Patil SP; Ramar K; Rogers R; Schwab RJ; Weaver EM; Weinstein MD. Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. J Clin Sleep Med 2009;5(3):263- 276.

OSA: Consequences

Neurocognitive

- Excessive daytime sleepiness
- Motor vehicle accidents
- Poor work performance
- Disrupted social interaction

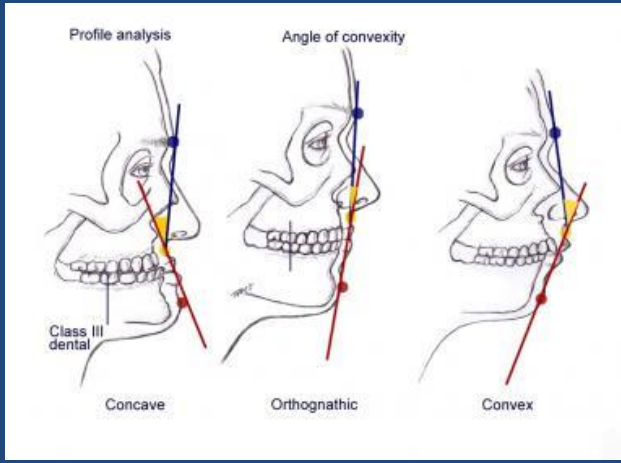
- Cardiovascular
- Systemic and pulmonary hypertension
- Ischemic cardiovascular events
- Arrhythmia
- Inflammatory
- Metabolic
- Quality of life

Etiology of OSA

Airway

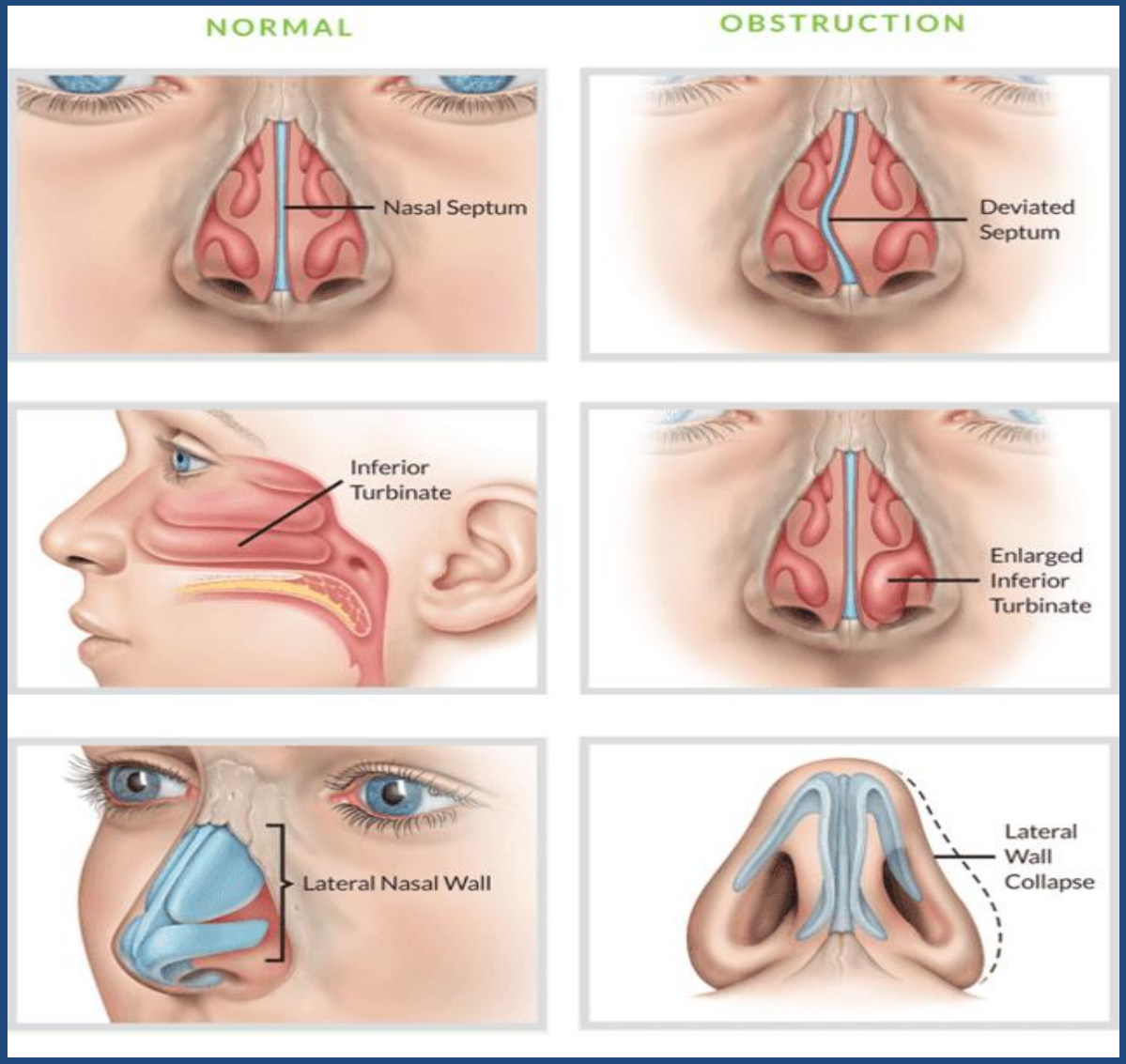
Restriction in Size of the Bony Compartment

- Mandibular hypoplasia
- Maxillary hypoplasia
- Both
- Narrow Palate
- Nasal Obstruction/ Deviated Nasal Septum



Narrow High Arched Palate

Deviated Nasal Septum



Increase in Soft Tissue Volume

- Deposition of fat around upper airway (in obesity)
- Enlargement of tongue
- Enlargement of soft palate
- Thickening of lateral pharyngeal walls
- Adenotonsillar enlargement
- Pharyngeal inflammation and edema

Pharyngeal Anatomy

- The posterior portion of the tongue makes up the anterior wall of the pharynx

- The oropharynx, nasophayrnx and hypopharynx make up the collapsible portion of the pharynx

Decrease in Pharyngeal Dilator Muscle Activity

- Pharyngeal dilator muscle activation mainly counteracts the collapsing forces of the airway.
- Sleep results in reduced pharyngeal muscle activity due to a reduction of input from respiratory drive centers and negative pressure receptors.
- This produces a reduced ability to prevent the collapsibility of the pharyngeal airway.

Eckert, D., Malhotra, A., Jordan, A. "Mechanisms of Apnea." *Prog Cardio Dis.* Vol. 51 No. 4 (2008):313-323.

Decrease in Lung Volume

Instability of Ventilator Control-loop Gain

Pharyngeal Nerve Muscle Damage

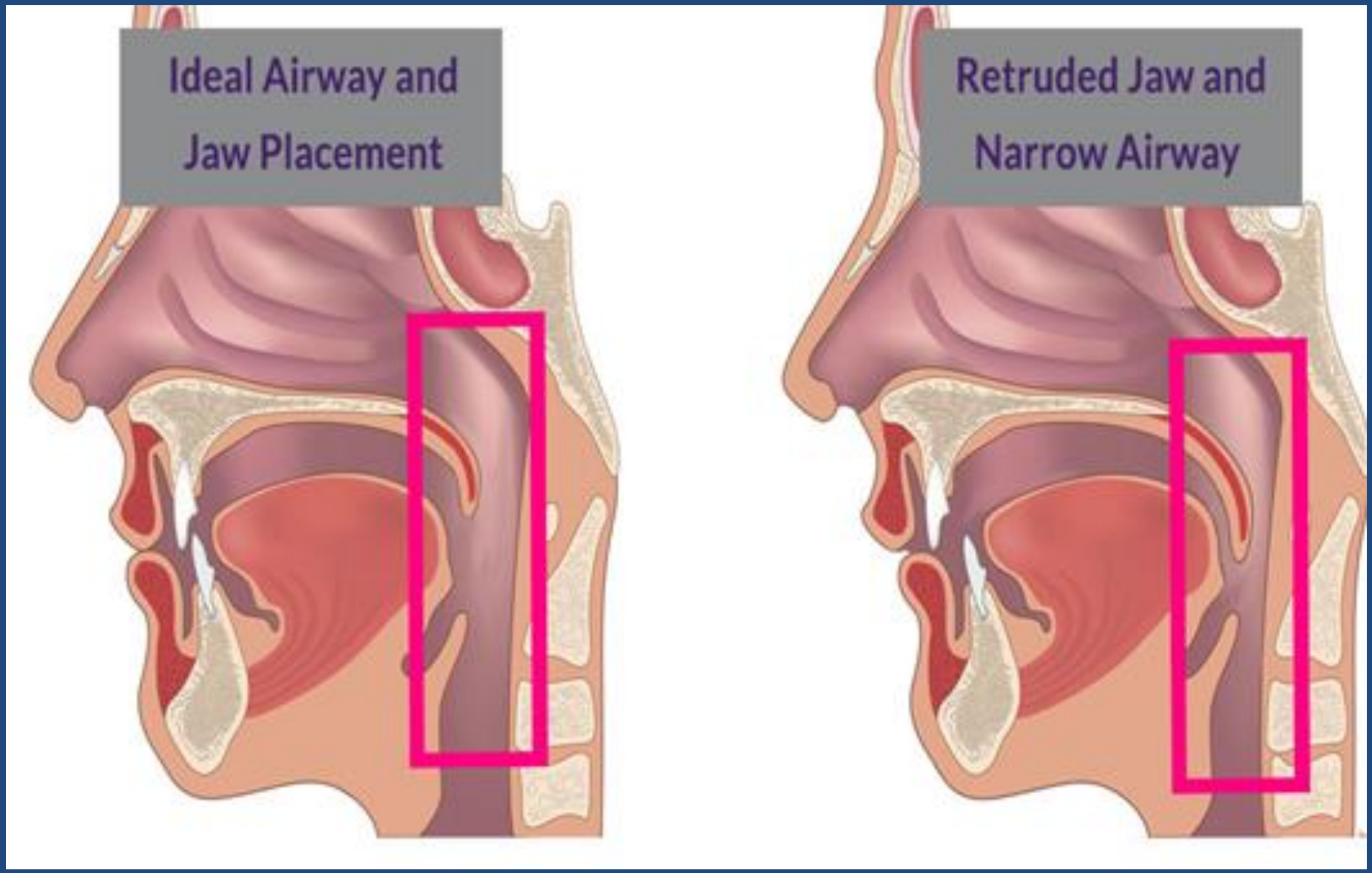
Role of the Dental Professionals

Or Are We Just About Teeth

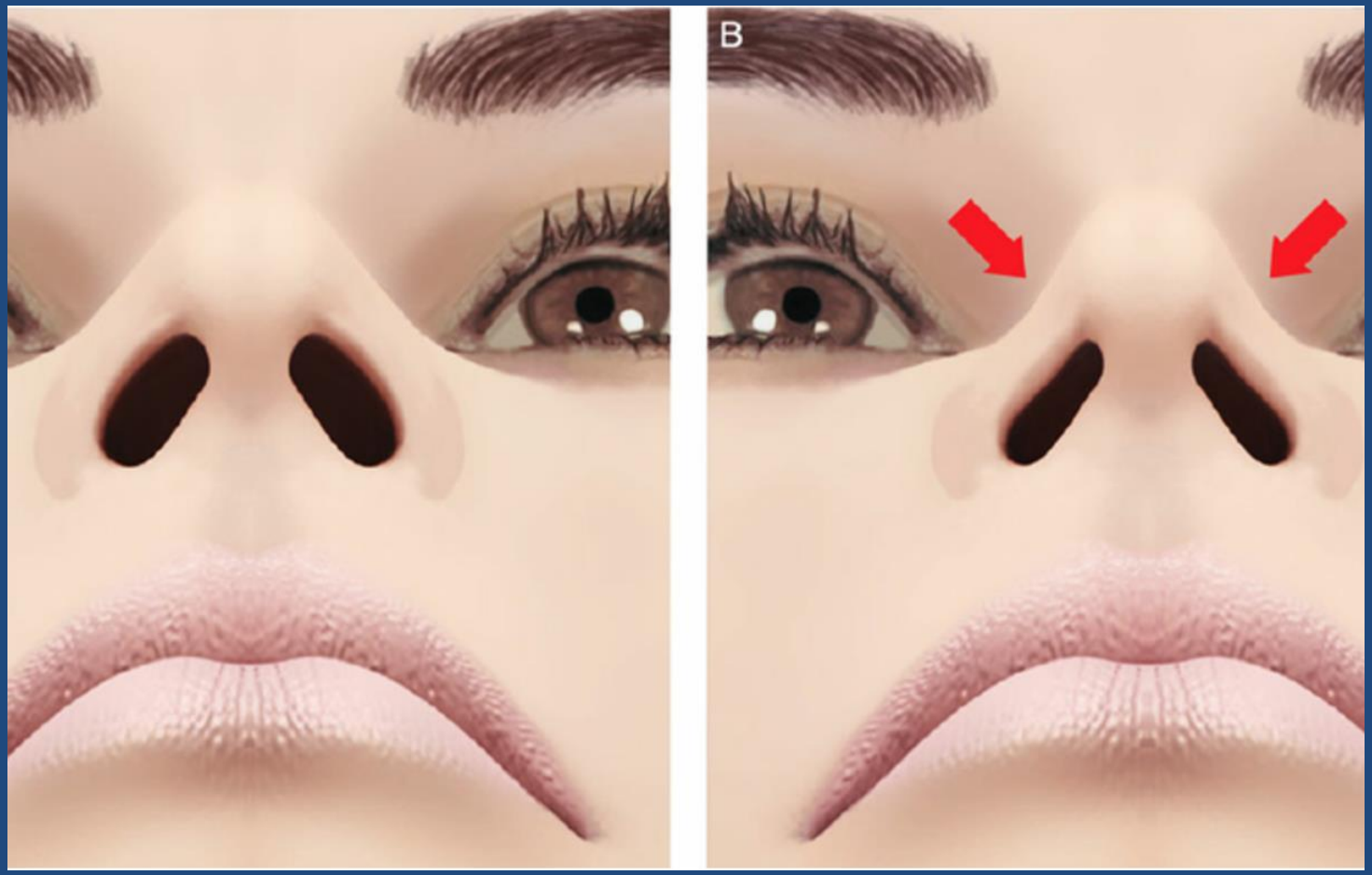
Oro Facial Characteristics of OSA

- Retrognathic Mandible and/or Maxilla
- Narrow Palate
- Large Neck Circumference
- Long Soft Palate
- Tonsillar and/or Adenoid Hypertrophy
- Nasal Septal Deviation
- Relative Macroglossia
- Tongue Tie
- Mouth Breather

Mandible


Ideal Airway and
Jaw Placement
Retruded Jaw and
Narrow Airway

Nasal Patency



Neck Size

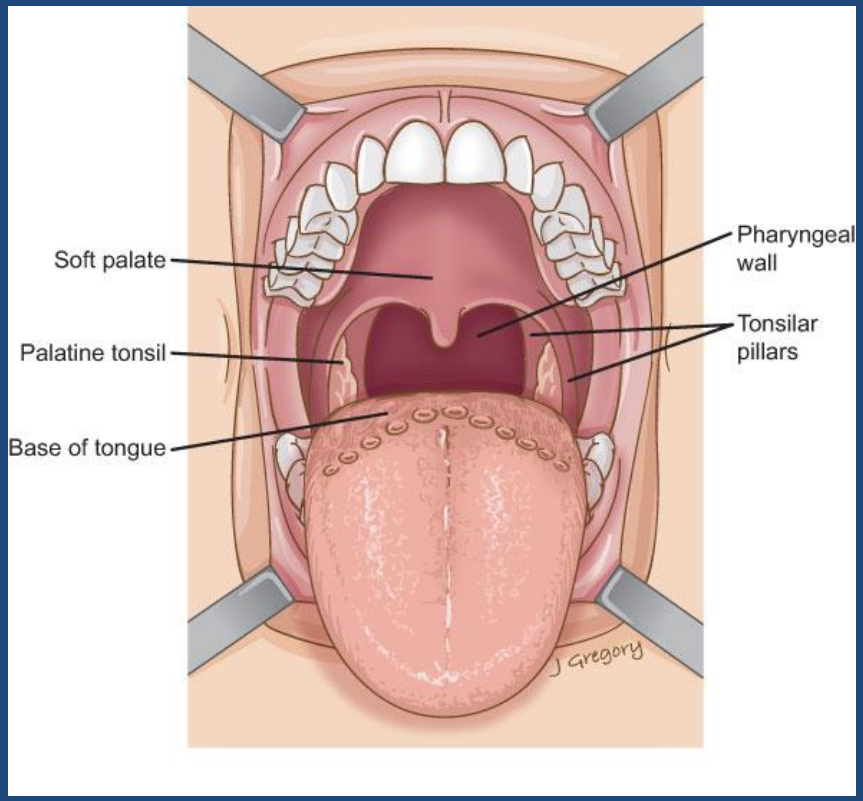
Neck Circumference

Men- Greater than 17 inches(43.2cms)

Women- Greater than 16 inches(40.6cms)

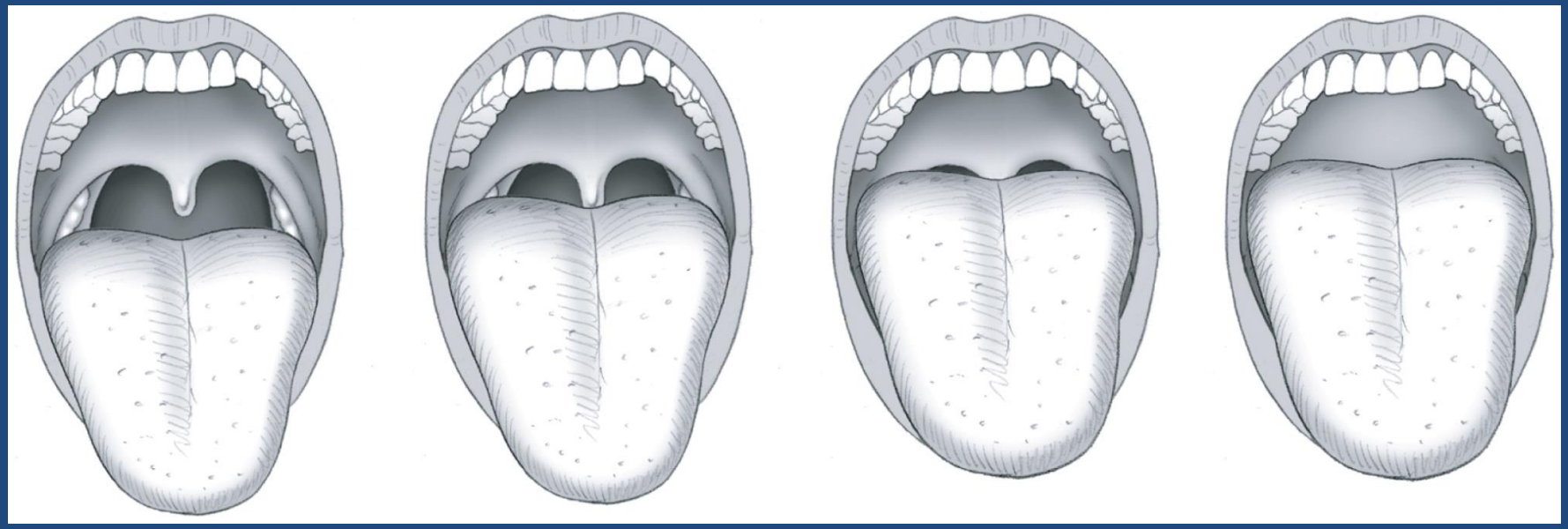
Narrow High Arch Palate

Posterior Palatal Area



Mallampati Scale

Class I | Class II | Class III | Class IV



Normal Airway

Sleep Apnea Airway

Nuckton TJ; Glidden DV; Browner WS et al. Physical examination: Mallampati score as an independent predictor of obstructive sleep apnea. *SLEEP 2006;29(7):903-908.*

Tonsillar Size Scoring

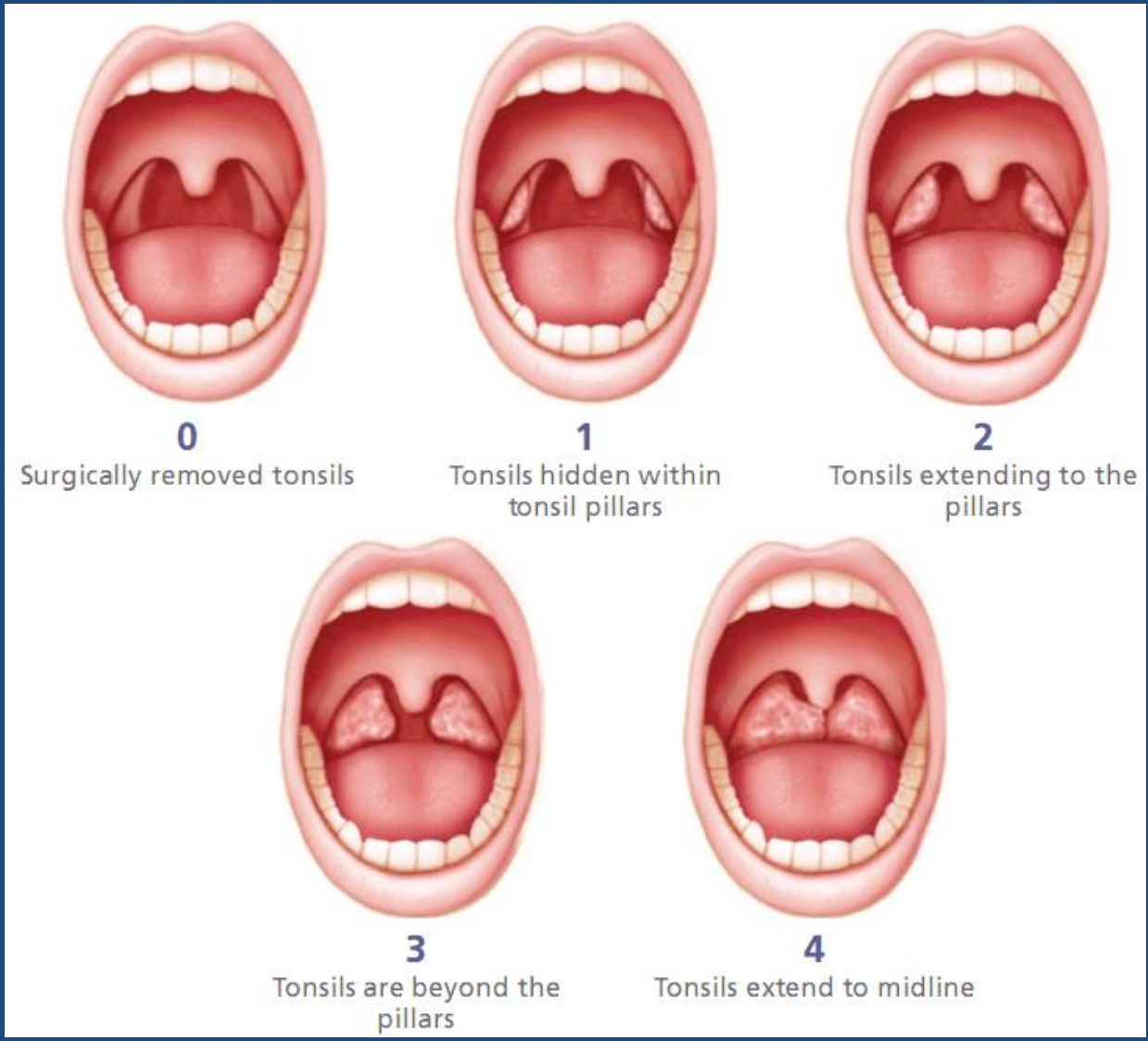


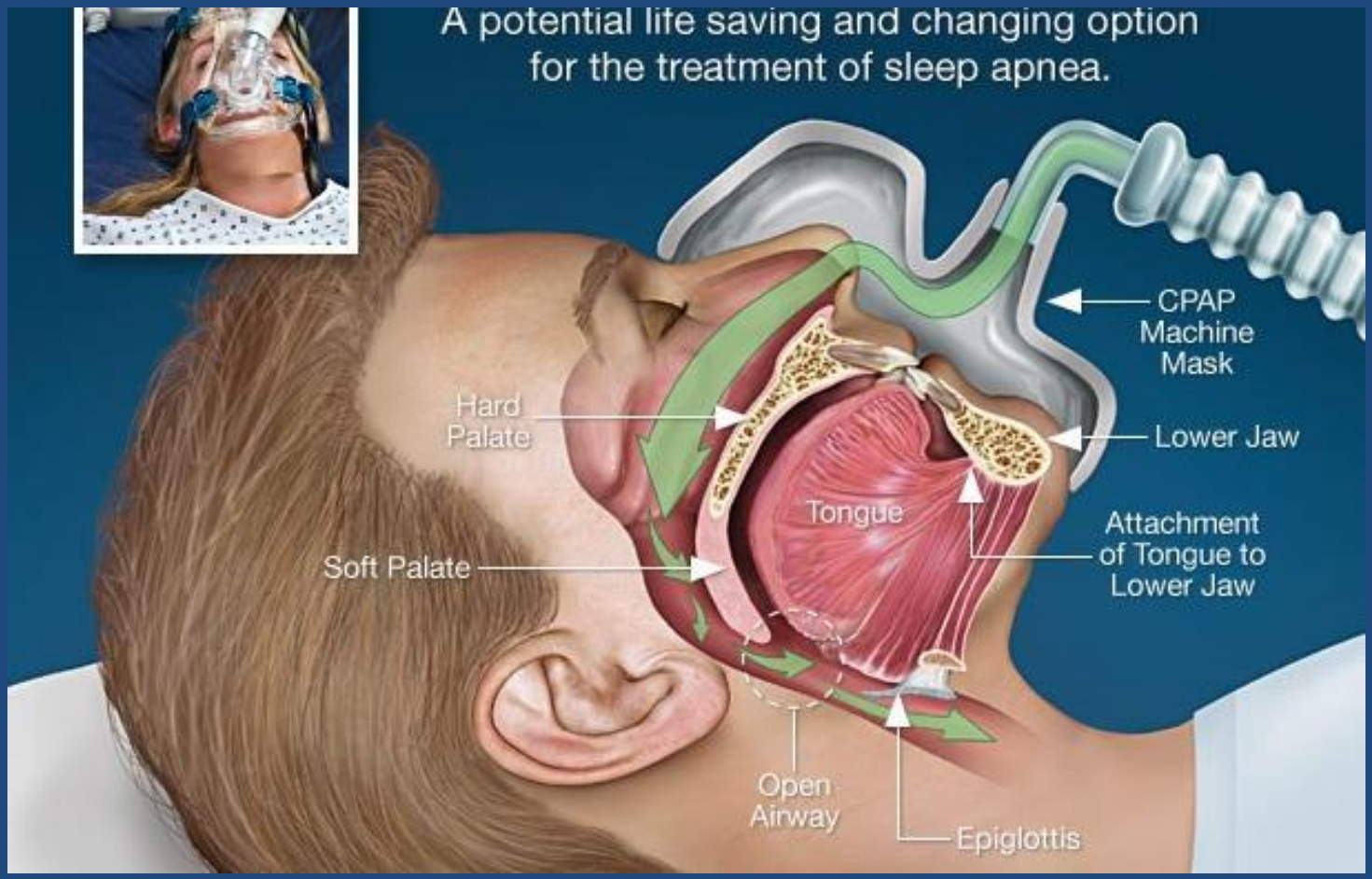
Table 2. Friedman Grading Scale[10]

Grade	Description
0	No tonsils seen
I	In tonsillar fossa
II	Visible beyond anterior pillars
III	Extended 3/4 of way to midline
IV	Completely obstructing airway; "kissing tonsils"

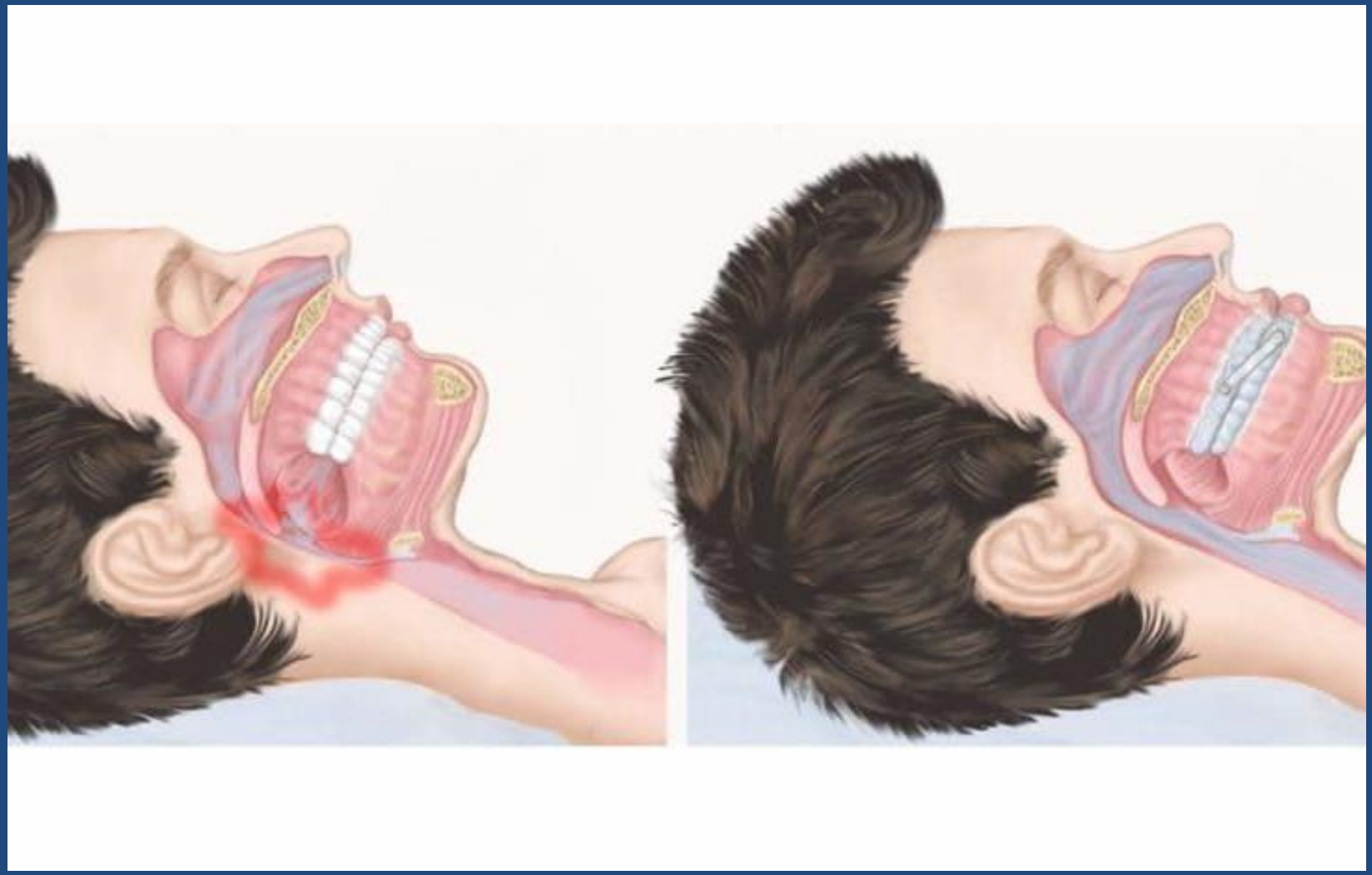
Obstructive Sleep Apnea

Treatment Modalities

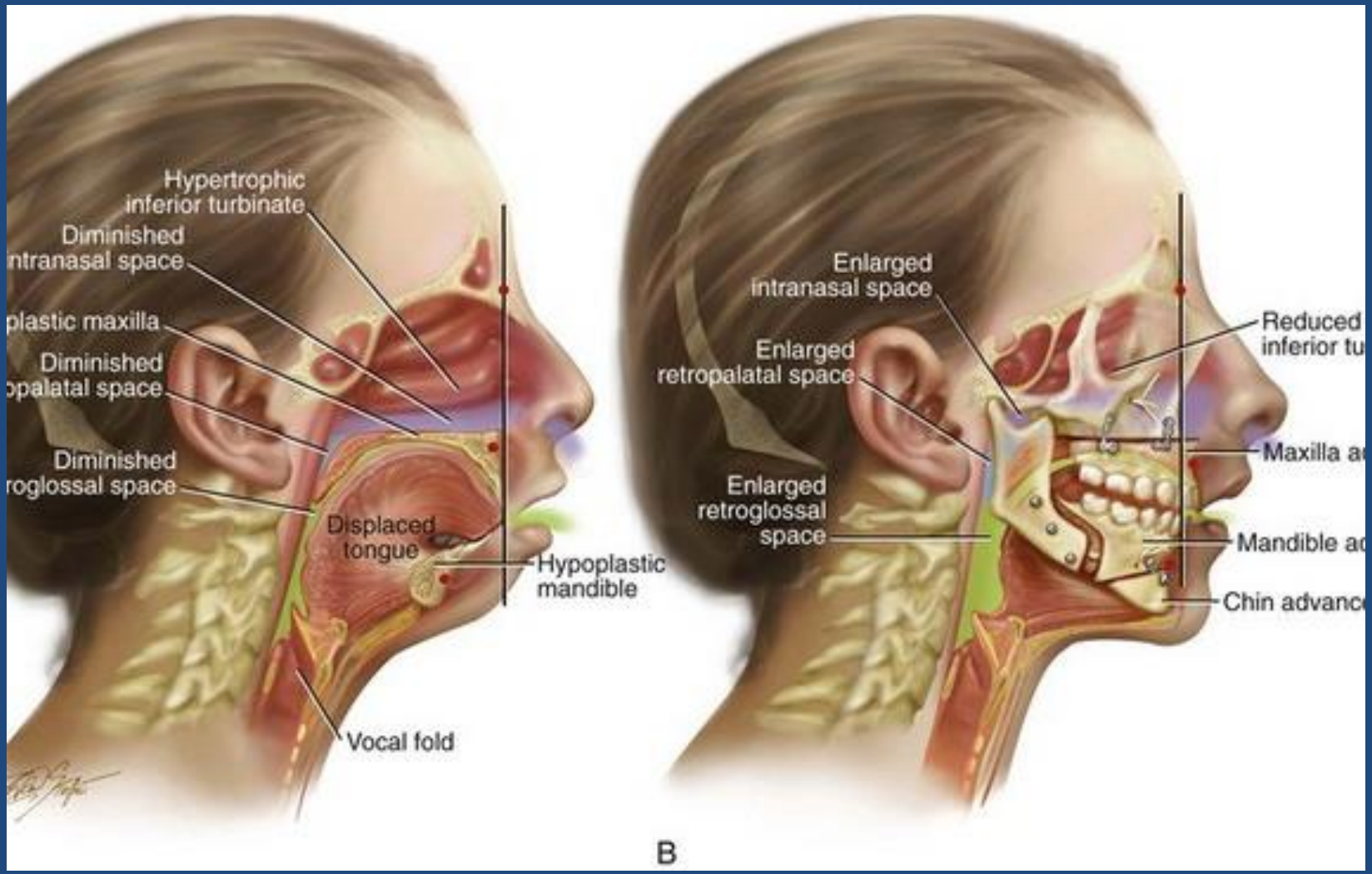
Management of OSA- CPAP



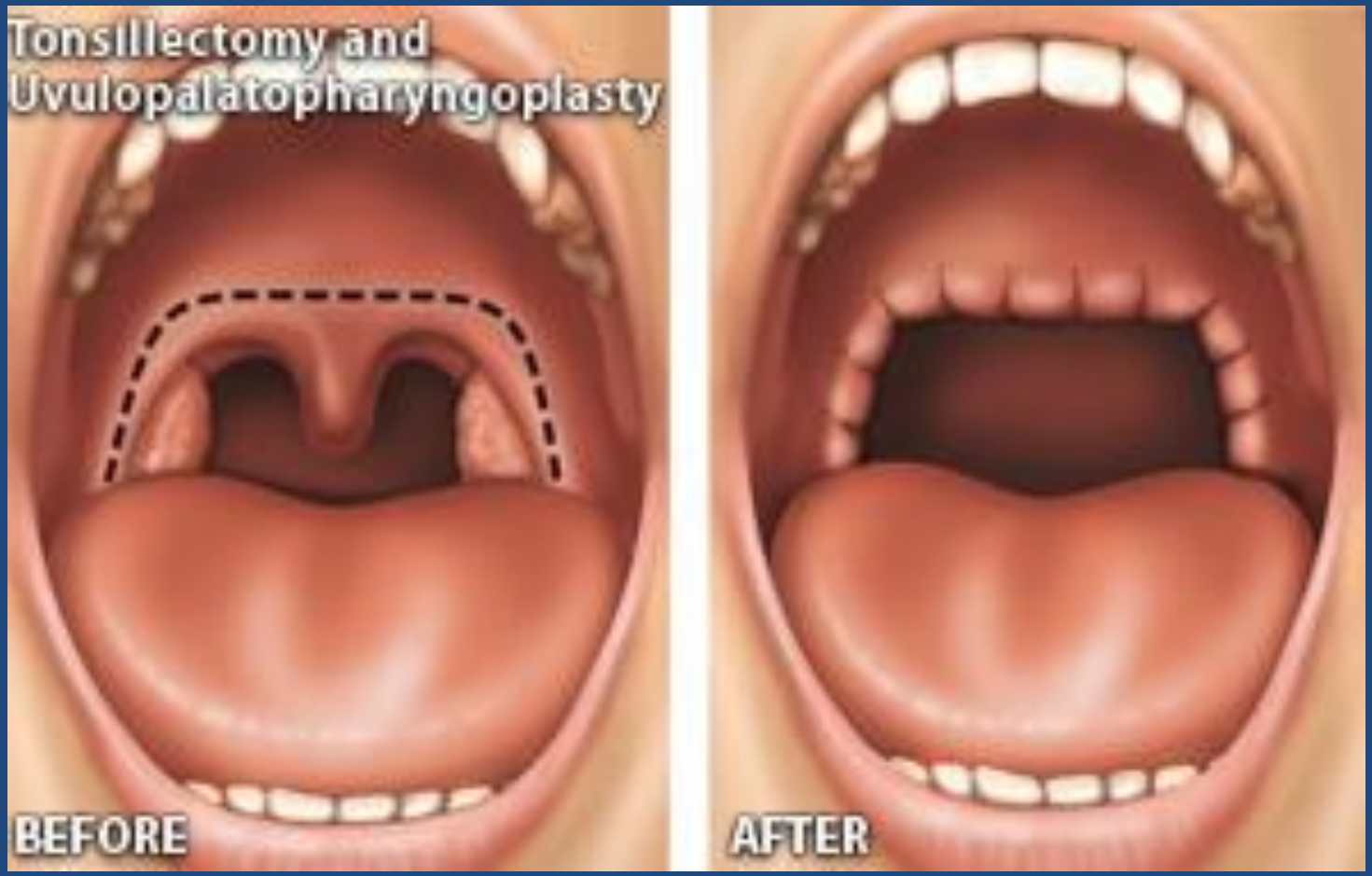
Management of OSA- OAT/MAD



Management of OSA-Orthognathic Surgery



Management of OSA- UPPP Surgery



Management of OSA- Alternatives

- Positional Therapy

- Weight Management

Airway and OSA in Children

Can we improve their quality of life?

Comorbidities associated with OSA in Children

OBSTRUCTIVE SLEEP APNEA IN CHILDREN IS A SERIOUS PROBLEM

- ADHD
- ENEURESIS
- FAILURE TO THRIVE
- LEARNING DISORDERS
- COGNITIVE DISORDERS
- BEHAVIORAL DISORDERS
- DISRUPTED SLEEP
- CARDIOVASCULAR PROBLEMS
- HYPERTENSION
- HYPOTROPHIC FACES AND JAWS
- DELAYED DEVELOPMENT OF MOTOR SKILLS
- EXECUTIVE DYSFUNCTION

ARE SOME OF THE COMORBID SYMPTOMS OF KIDS' OSA

PEDIATRIC QUESTIONNAIRE

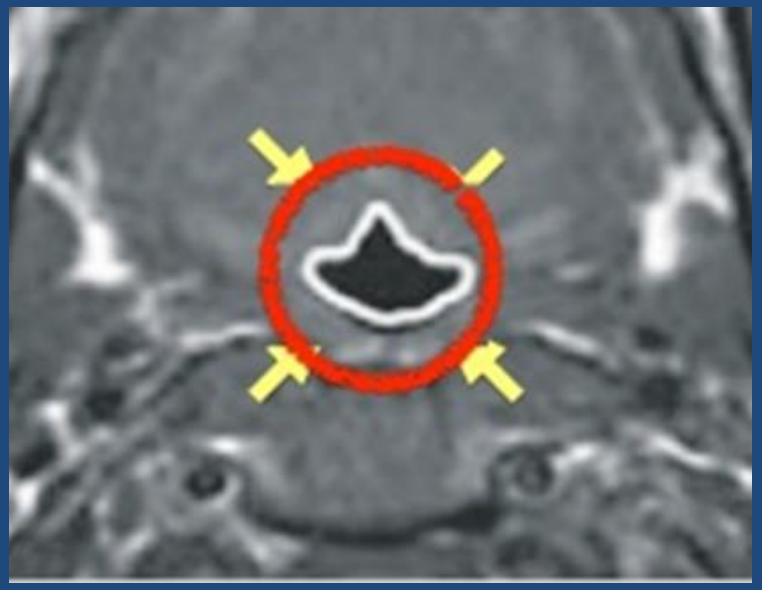
1) Does your child have trouble going to bed or falling asleep?
2) Awaken during the night and have trouble returning to sleep?
3) Does he/she tend to breathe through their mouth during the day or during sleep?
4) Have dry mouth or bad breath upon waking in the morning?
5) Have you noticed any of the following while your child is sleeping?
    a) Snoring, heavy or loud breathing?
    b) Break or pause in breathing?
    c) Gasp, choke, or struggle to breathe?
    d) Restless or agitated sleep? Grinding teeth?
    e) Abnormal head posture (hyper-extension, etc.)
    f) Excessive sweating?
    g) Wetting the bed?
6) Have you noticed any of the following during the day?
    a) Difficulty waking?
    b) Wakes with headaches?
    c) Groggy, tired or "out of it"?
    d) Hyperactive?
    e) Teachers commented?
7) Child often:
    a) Does not seem to listen when spoken to directly?
    b) Has difficulty organizing tasks?
    c) Easily distracted by extraneous stimuli?
    d) Fidgets with hands or feet or squirms in seat?
    e) Interrupts or intrudes on others?
8) Is your child frequently sick, have a history of sore throat, ear infections, sinus infections or allergies?
9) Stop growing at a normal rate at any time since birth? Overweight?
10) Habits such as: pacifier/ thumb sucking/ lip biting/ other?

Modified from: Chervin, R D, et al. "Pediatric Sleep Questionnaire: Prediction of Sleep Apnea and Outcomes." Archives of Otolaryngology--Head & Neck Surgery., U.S. National Library of Medicine, Mar. 2007, www.ncbi.nlm.nih.gov/ pubmed/17372077.

Effect of Narrow Airway

Narrow Airway Dynamics

- Narrow Irregular Airway
- Increased Shear forces
- Negative Pressure pull on soft tissues
- Tissue pulling and Trauma (Snoring)
- Impairment of Mechanoreceptors
- Uncoordinated Diaphragm and Upper Airway Muscle Contraction
- Disordered Breathing



Association of Sleep Disordered Breathing

- Form Problems
- Function Problem

Facial Profile and SDB

Mouth Breathers

Etiology of Malocclusion

John Mew's Tropic Premise- BDJ, 1981

"If the tongue at rest is against the palate with the lips slightly sealed and the teeth in or near contact, there will be ideal facial and dental development…. Something RARE in industrialized societies…."

Contradicting Philosophies

Periodontics and Implantology

Soft Tissue follows Hard Tissue

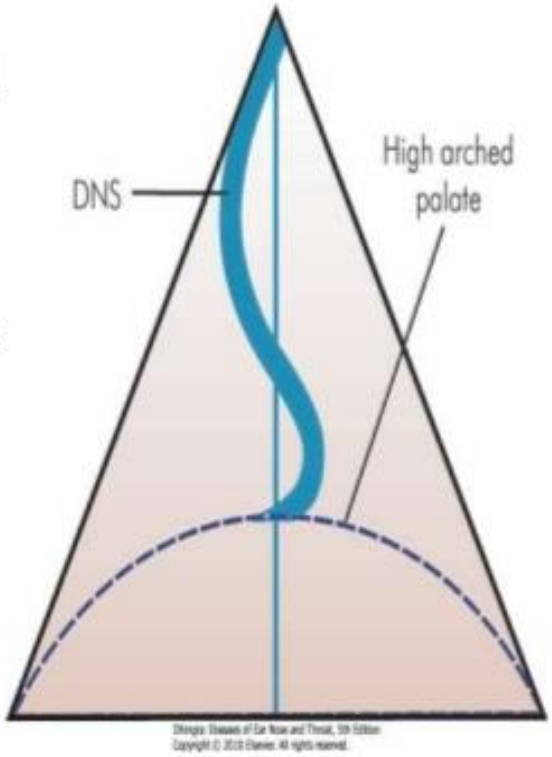
Maxillofacial Orthopedics

Bone sets the tone but Tissue is the Issue- Mark Cruz

Narrow Palate and Deviated Nasal Septum

Development errors

- Inconsistency between growth of nasal septum and nasal cavity. Nasal septum growths quicker then nasal cavity.
- Unequal growth between the palate and the base of skull –>buckling of nasal septum
- Adenoid hypertrophy->high arched palate ->DNS
- Also seen in cleft lip & palate and dental abnormalities



Palatal Expansion- Effect on Airway

Healthy Sleep Habits in Children

The American Academy of Sleep Medicine (AASM) offers some tips to help your child sleep better:

- Follow a consistent bedtime routine. Set aside 10 to 30 minutes to get your child ready to go to sleep each night.
- Establish a relaxing setting at bedtime.
- Interact with your child at bedtime. Don't let the TV, computer or video games take your place.
- Keep your children from TV programs, movies, and video games that are not right for their age.
- Do not let your child fall asleep while being held, rocked, fed a bottle, or while nursing.
- At bedtime, do not allow your child to have foods or drinks that contain caffeine. This includes chocolate and sodas. Try not to give him or her any medicine that has a stimulant at bedtime. This includes cough medicines and decongestants.

Questions???

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