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Snoring and Sleep Apnea in Adults :
Diagnostic and ENT Treatment Protocols

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  - *Australasian Society for Tongue and Lip Ties*
  - *Buteyko Breathing Educators Association*
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Stanford-Trained Sleep Surgeon:

- Multidisciplinary perspective to advanced treatment of OSA.
- Sleep Medicine, Sleep Dentistry, Otolaryngology (ENT), Maxillofacial Surgery, and Myofunctional Sciences.
- Clinical Research and Evidence-Based Medicine.

Stanford Sleep Surgery Fellowship Alumni Network

the BREATHE INSTITUTE

Our team takes a multidisciplinary approach to treat pediatric and adult sleep disorders, as well as snoring and mouth breathing issues.

STRUCTURAL

Nasal obstruction, snoring, sleep-apnea, and tongue-tie, are symptoms of structural issues. Precision diagnostics enables us to identify and treat the root causes of sleep disordered breathing.

FUNCTIONAL

Myofunctional therapy includes facial and tongue exercises, as well as functional modification techniques, to promote proper tongue position and improve breathing, chewing, and swallowing.

BEHAVIORAL

Sleep hygiene includes syncing your sleep with natural biological rhythms and integrating specific evidence based methods to help both adults and children achieve higher quality sleep.

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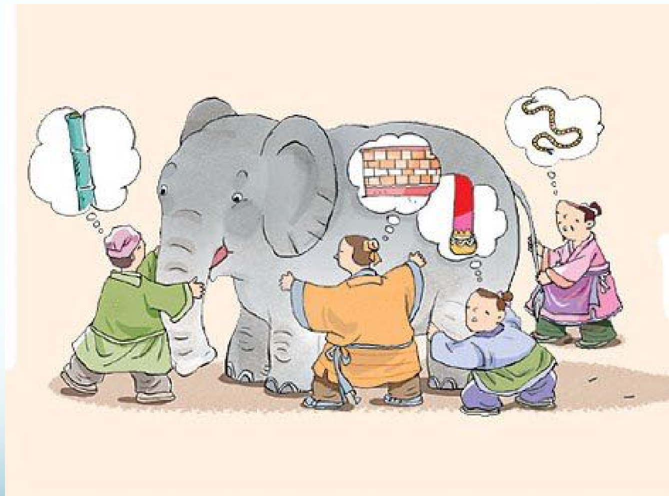
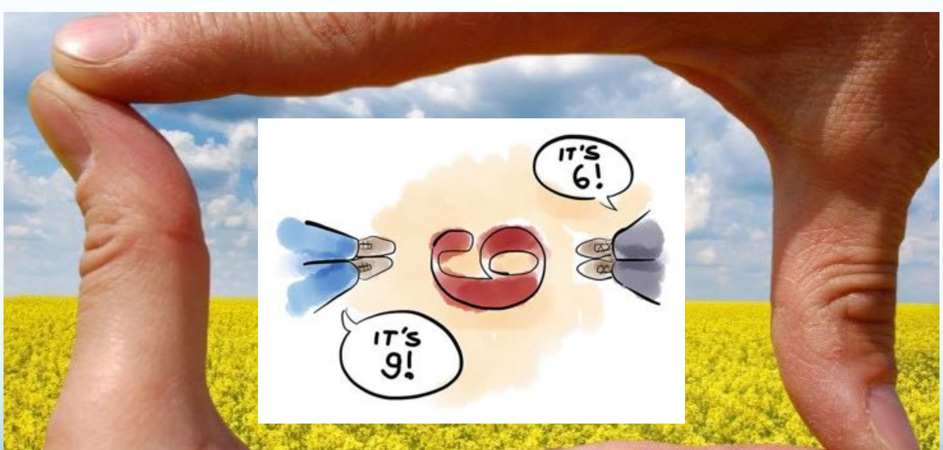
Sleep & Breathing Education:
Different Viewpoints, Experience, and Expertise



Parable: *Blind Men and The Elephant*

Perspective



Multidisciplinary Approach: Different perspectives to a common problem.

Snoring

- Primary snoring is estimated to affect ____ % of the general population?

A) 1%

B) 3-7%

C) 20-40%

D) 50-75%

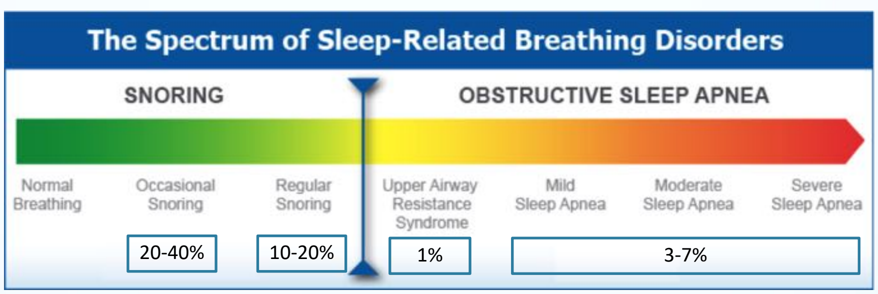
Snoring

Primary snoring (without obstructive sleep apnea) is estimated to affect about **20-40%** of the general population **with half of these having sufficiently problematic snoring** to cause consternation to bed partners or in social situations.

Reference: Davey, Marianne J. "Epidemiological study of snoring from a random survey of 1075 participants." *British Snoring & Sleep Apnoea Association.*

Advanced Surgical Techniques in Snoring and Obstructive Sleep Apnea. Ch12- Palatal Implants for Treatment of Snoring, Brian W. Rotenberg. 2013.

Prevalence: Literature-Based Epidemiology



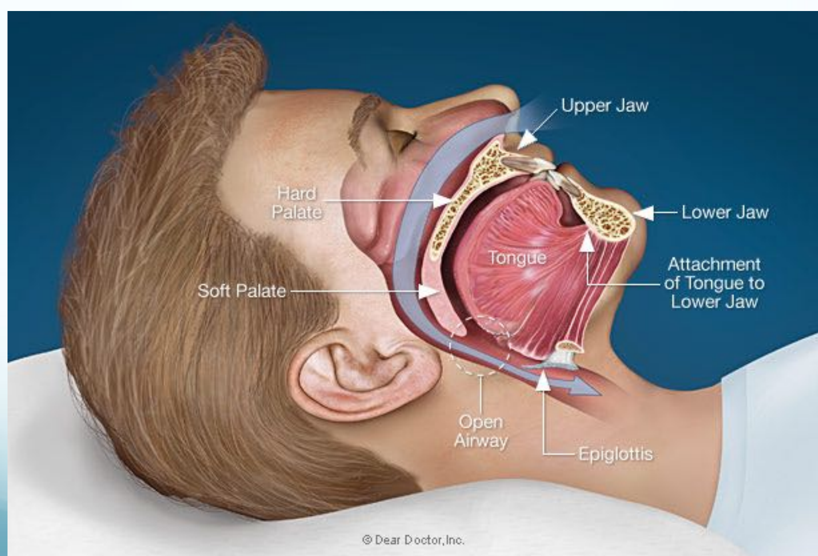
- Incidence of UARS/OSA may be as high as 9% in women and 24% in men.
- 80-90% of patients remain undiagnosed.
- Snoring is often the first sign of sleep-disordered breathing.

References:
(1) Peppard, P.E., Young, T., Barnet, J.H., Palta, M., Hagen, E.W. and Hla, K.M., 2013. Increased prevalence of sleep-disordered breathing in adults. *American journal of epidemiology*, *177*(9), pp.1006-1014. (2) Punjabi, Naresh M. "The epidemiology of adult obstructive sleep apnea." *Proceedings of the American Thoracic Society*5.2 (2008): 136-143. (3) Young T, Evans L, Finn L, et al. Estimation of the clinically diagnosed proportion of sleep apnea syndrome in middle aged men and women. Sleep 1997;20:705–706. (4) Vat, S., Haba-Rubio, J., Andries, D., Tobback, N., Tafti, M. and Heinzer, R., 2013. Prevalence of the upper airway resistance syndrome in the general population. *Sleep Medicine*, *14*, pp.e295-e296.

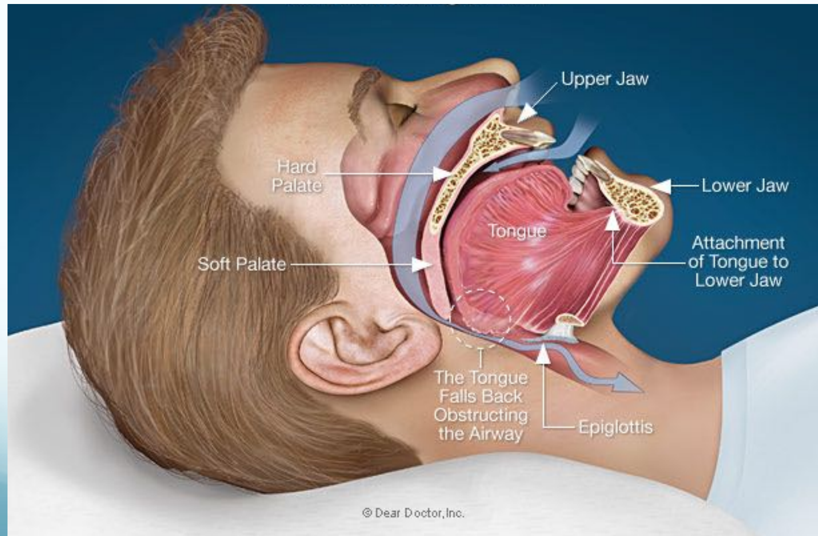

F·R·I·E·N·D·S

Why do people snore?

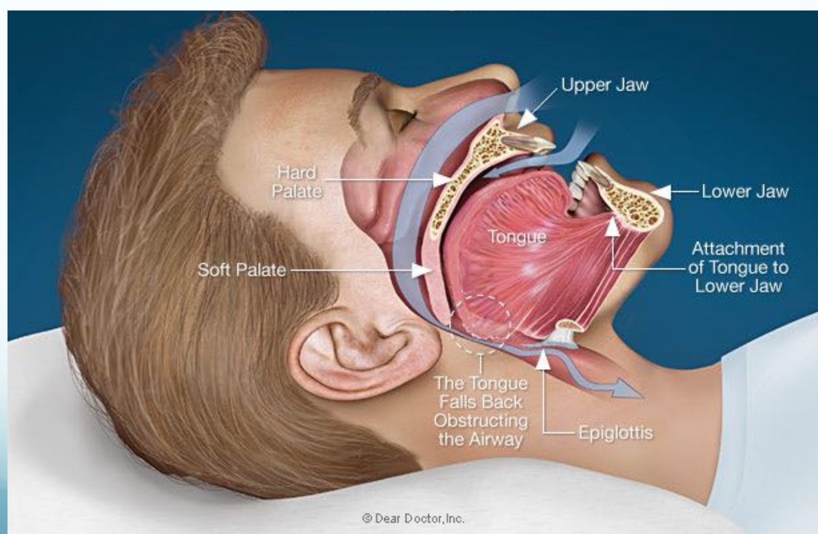
The Effect of Sleep on Breathing



Snoring

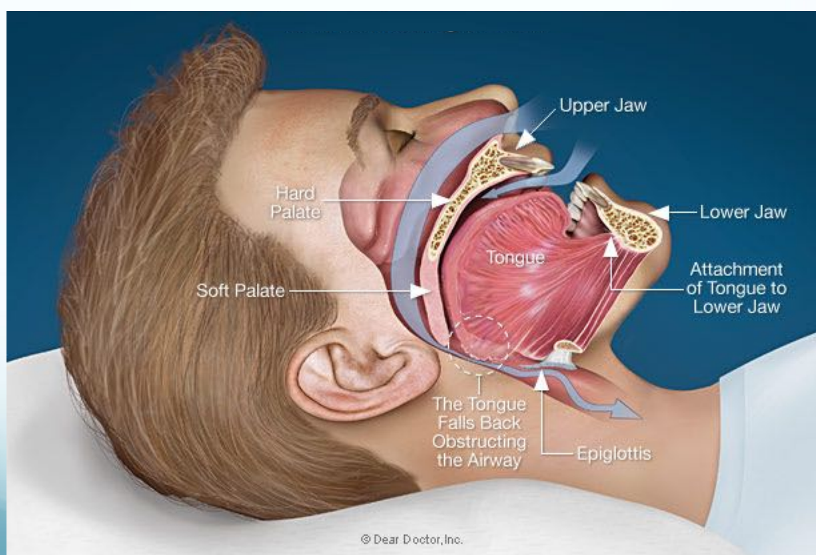


Obstructive Sleep Apnea



SpO2%: 82%

Upper Airway Resistance



Health-Related Consequences

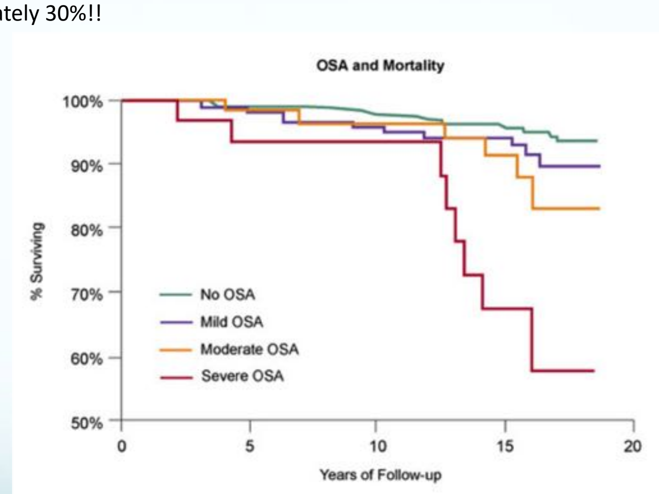
Decreased Quality of Life
- Poor job performance
- Work-related accidents
- Motor vehicle accidents
- Family discord
- Depression

Cardiovascular/ Pulmonary
- Cardiac arrhythmias
- Myocardial Ischemia
- Pulmonary Hypertension
- Congestive heart failure

Systemic - Metabolic
- Hypertension
- Insulin Resistance- Diabetes
- Metabolic Syndrome- Obesity

Neurologic
- Neurocognitive dysfunction
- TIA/ Stroke

Marin et al. 2005 – Lancet:
Untreated, the 15-year cardiovascular mortality for adults with severe disease is approximately 30%!!



Adjusted mortality hazards ratios of 1.4, 1.7, and 3.8 for mild, moderate, and severe disease, respectively. Treatment with CPAP reduces this risk. But, 36% of patients with severe OSA in this study refused treatment with CPAP.

Sleep Disordered Breathing

- Common
- Dangerous
- Costly

➔ Treatable.

Does he have a problem?

Assessment of Snoring:

- **Intensity**
  - Visual Analogue Scale (1-10); "none, mild, moderate, severe very severe"; measured in decibels
  - Described as "Slightly louder than breathing, as loud as talking, louder than talking"
  - Audible if: in the same room, in an adjacent room, downstairs/ anywhere in the house, next-door neighbor.
- **Frequency of snoring**
  - Days of the week
  - % of time spent snoring during sleep
- **Bedpartner Complaints**
  - How much has your bedpartner's snoring bothered you: not at all, a little bit, quite a bit, moderately, extremely (sleeping in another room).

Assessment of Snoring: "Snore Score" Snoring Intensity and Duration

The Snore Score is a measure of snoring **intensity** and **frequency** used to compare snoring across nights and between people. Essentially, it is a function of the volume and duration of snoring. The average user scores around 20, while a score more than 100 puts you in the worst 15% of snorers.

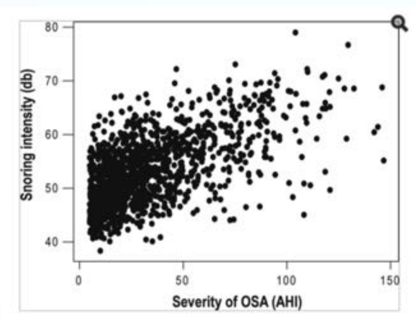
AASM Practice Guidelines

Diagnosis

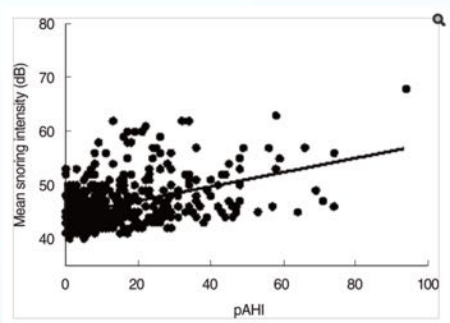
The presence or absence and severity of OSA must be determined before initiating treatment in order to identify those patients at risk of developing the complications of sleep apnea, guide selection of appropriate treatment and to provide a baseline to establish the effectiveness of subsequent treatment. Diagnostic criteria for OSA are based on clinical signs and symptoms determined during a comprehensive sleep evaluation, which includes a sleep oriented history and physical examination, and findings identified by sleep testing (Standard).[4] The overall evaluation of patients suspected of having OSA is summarized in Figure 1.

Ref: Epstein, L.J., Kristo, D., Strollo, P.J., Friedman, N., Malhotra, A., Patil, S.P., Ramar, K., Rogers, R., Schwab, R.J., Weaver, E.M. and Weinstein, M.D., 2009. Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. *Journal of Clinical Sleep Medicine*, *5*(03), pp.263-276.

Snoring Intensity:
Positively associated with OSA Severity



Correlation between severity of OSA and snoring intensity



Correlation between peripheral arterial tone apnea hypopnea index (pAHI) and snoring intensity.

Reference: Maimon, N. and Hanly, P.J., 2010. Does snoring intensity correlate with the severity of obstructive sleep apnea?. *Journal of clinical sleep medicine: JCSM: official publication of the American Academy of Sleep Medicine*, *6*(5), p.475.

Reference: Kim, J.W., Lee, C.H., Rhee, C.S. and Mo, J.H., 2015. Relationship between snoring intensity and severity of obstructive sleep apnea. *Clinical and experimental otorhinolaryngology*, *8*(4), p.376.

Snoring Frequency:
U-shaped association with OSA

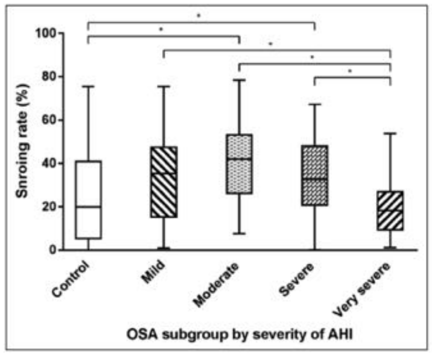


Figure 1. Comparison of the snoring rates among obstructive sleep apnea (OSA) subgroups by the severity of the apnea-hypopnea index (AHI).
*P < .05.

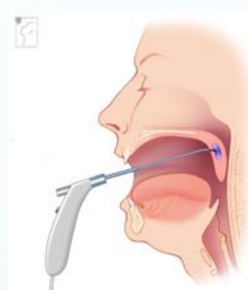
References: Hong, S.N., Yoo, J., Song, I.S., Joo, J.W., Yoo, J.H., Kim, T.H., Lee, H.M., Lee, S.H. and Lee, S.H., 2017. Does Snoring Time Always Reflect the Severity of Obstructive Sleep Apnea?. *Annals of Otology, Rhinology & Laryngology*, *126*(10), pp.693-696.

Laser-Assisted Uvulopalatoplasty for Obstructive Sleep Apnea: A Systematic Review and Meta-Analysis

Macario Camacho, MD; Nicholas B. Nesbitt; Evan Lambert; Sungjin A. Song, MD; Edward T. Chang, MD, MS; Stanley Yung Liu, MD, DDS; Clete A. Kushida, MD, PhD; Soroush Zaghi, MD

Journal of Sleep; 2017 Jan 28: 10.1093/sleep/zsx004

- There was a worsening of the AHI among 44% of patients who underwent LAUP for treatment of snoring.
- Laser-assisted uvulopalatoplasty (LAUP) can potentially worsen obstructive sleep apnea (OSA).
- Primary snoring patients who no longer snore after LAUP should be tested for OSA post-operatively if they develop signs and symptoms of OSA.



Statement of Significance
There are three important points. First, laser-assisted uvulopalatoplasty (LAUP) can potentially worsen obstructive sleep apnea (OSA; 44% of patients with individual data). Second, primary snoring patients who no longer snore after LAUP should be tested for OSA post-operatively if they develop signs and symptoms of OSA. Third, given that reflexogenic dilation of the pharyngeal airway is mediated by pharyngeal mucosa afferent nerve fibers, it is possible that by destroying the surface of the soft palate with a laser, that there may be blunting of the reflexogenic dilation of the pharyngeal airway. Therefore, LAUP should be performed with caution or not performed at all. Proper patient counseling is essential.

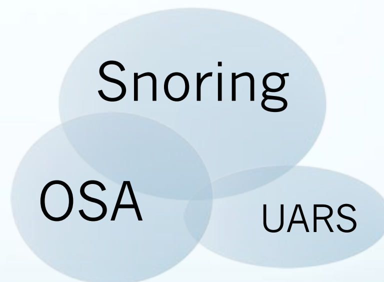
Evaluation Protocol

Step 2: Clinical History

- Snoring
- Witnessed apneas
- Gasping/choking episodes
- Difficulty falling asleep
- Restless / unrefreshing sleep
- Clenching or grinding
- Predominant side or stomach sleeping
- Mouth vs. Nasal Breathing
- Morning headaches
- Jaw pain
- Dry mouth
- Daytime sleepiness
- Attention and concentration
- Stress, anxiety, depression
- Fatigue, energy levels
- Systemic effects: nocturia, high blood pressure, obesity

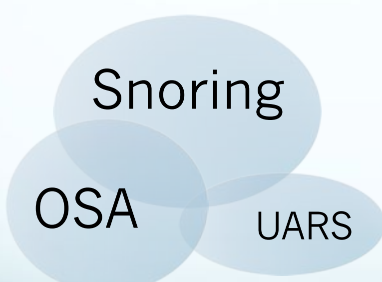
Snoring is only one element of sleep-disordered breathing

- Sleepiness
- Fatigue
- Daily functioning
- Physical health
- Emotional symptoms
  - Anxiety
  - Depression
  - Insomnia
- Impact on social interactions

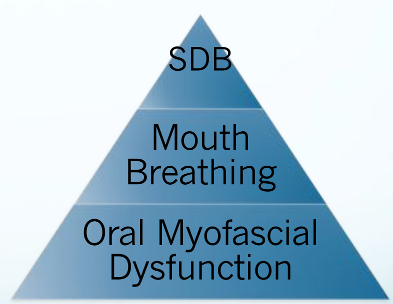


Snoring is only one element of sleep-disordered breathing

Sleep-disordered breathing is only one element of airway function disorder



Spectrum of Sleep Disordered Breathing



Spectrum of Airway Function Disorder

Step 3

Diagnostic Testing
Assessment of Condition Severity

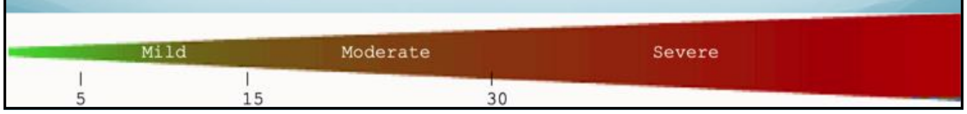
- **Is this patient in need of immediate medical attention?**

Questionnaires

- Clinical History
- STOP-BANG
- Epworth Sleepiness Scale
- Fatigue Severity Score

Auxiliary Tools

- Snore Lab / Sleep Time (Actigraphy)
- Video Camera Study
- Pulse Oximetry
- Cone-beam CT / lateral cephalogram
- **Polysomnography**



Diagnostic Testing: Adults

Home Sleep Test (HST)

- 6 channels
- 2 or 3 wires
- Healthy patients

In-Lab Polysomnography (PSG)

- At least 12 channels
- Minimum of 22 wires
- Complex patients

OSA Severity Scale

Adults-

- **Respiratory Indices (AHI / RDI/ ODI)**
  - Normal: < 5 events per hour
  - Mild: ≥ 5 – 15 events per hour
  - Moderate: ≥ 15 – 30 events per hour
  - Severe: ≥ 30 events per hour
- **Lowest Oxygen Saturation**
  - Normal: > 92 %
  - Mild: 88-92%
  - Moderate: <88%
  - Severe: <80%
- **Time spent below 90% SpO2**
  - Normal: 0%
  - Mild: <2%
  - Moderate: 2-10%
  - Severe: > 10%
  - Very severe: >20%

56 year-old male with loud snoring, gasping during sleep, and witnessed apnea events.

Sleep Summary

Start Study Time:	11:12:51PM
End Study Time:	6:12:21AM
Total Recording Time:	6 hrs, 59 min
Total Sleep Time	**6 hrs, 9 min**
% REM of Sleep Time:	22.2

Respiratory Indices

	REM	NREM	All Night
pRDI:	36.3	72.9	**64.4**
pAHI:	35.5	72.5	**63.9**
ODI:	22.2	64.2	**54.4**

Indices are calculated using technically valid sleep time of 5 hrs, 47 min.
pRDI/pAHI are calculated using oxi desaturations ≥ 3%

Oxygen Saturation Statistics

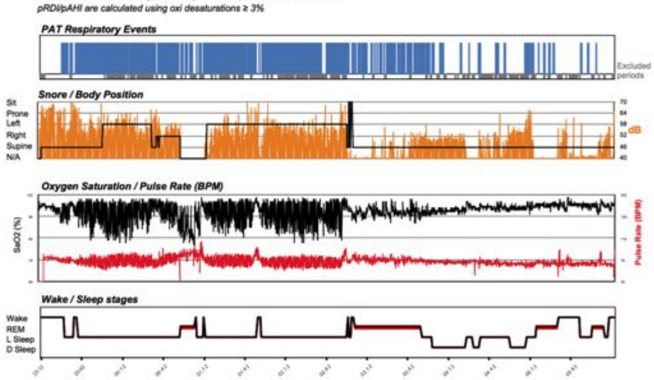
Mean:	92	Minimum:	77	Maximum:	99
Mean of Desaturations Nadirs (%):					86

Oxygen Desatur. %:	4-9	10-20	>20	Total
Events Number	121	194	0	315
Total	38.4	61.6	0.0	100.0

Oxygen Saturation	<90	<88	<85	<80	<70
Duration (minutes):	73.2	46.2	21.5	1.2	0.0
Sleep %	19.8	12.5	5.8	0.3	0.0

Pulse Rate Statistics during Sleep (BPM)

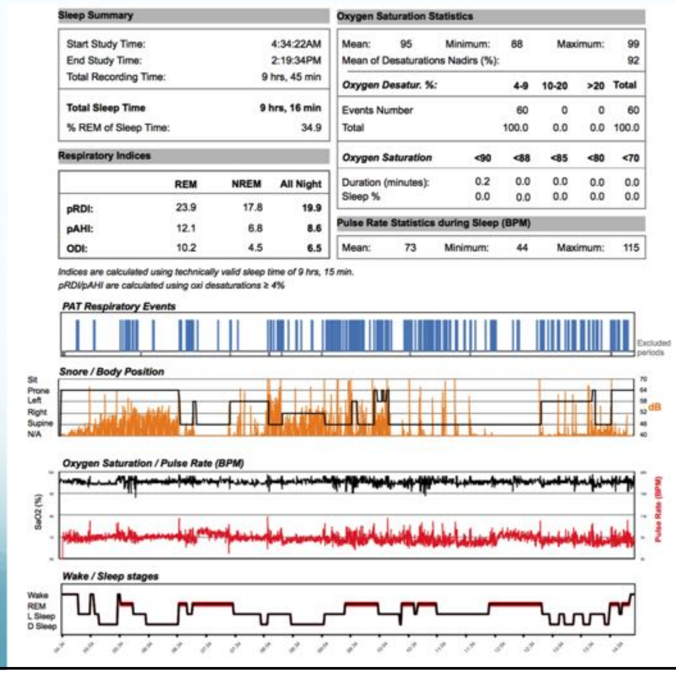
Mean:	73	Minimum:	N/A	Maximum:	105



Diagnosis: very severe OSA

<u>* Needs medical attention*</u>

23 year-old male with restless sleep, unrefreshing sleep, snoring, and mouth breathing.



Sleep Summary

Start Study Time:	4:34:22AM
End Study Time:	2:19:34PM
Total Recording Time:	9 hrs, 45 min
Total Sleep Time	**9 hrs, 16 min**
% REM of Sleep Time:	34.9

Respiratory Indices

	REM	NREM	All Night
pRDI:	23.9	17.8	19.9
pAHI:	12.1	6.8	8.6
ODI:	10.2	4.5	6.5

Indices are calculated using technically valid sleep time of 9 hrs, 15 min.
pRDI/pAHI are calculated using oxi desaturations ≥ 4%

Oxygen Saturation Statistics

Mean: 95 Minimum: 88 Maximum: 99
Mean of Desaturations Nadirs (%): 92

Oxygen Desatur. %:	4-9	10-20	>20	Total
Events Number	60	0	0	60
Total	100.0	0.0	0.0	100.0

Oxygen Saturation	<90	<88	<85	<80	<70
Duration (minutes):	0.2	0.0	0.0	0.0	0.0
Sleep %	0.0	0.0	0.0	0.0	0.0

Pulse Rate Statistics during Sleep (BPM)

Mean: 73 Minimum: 44 Maximum: 115

Diagnosis:
mild to moderate OSA

OSA Severity Scale

- **Adults- AHI / RDI/ ODI**
  - Normal: < 5 events per hour
  - Mild: ≥ 5 – 15 events per hour
  - Moderate: ≥ 15 – 30 events per hour
  - Severe: ≥ 30 events per hour
- **Lowest Oxygen Saturation**
  - Normal: > 92 %
  - Mild: 88-92%
  - Moderate: <88%
  - Severe: <80%
- **Time spent below 90% SpO2**
  - Normal: 0%
  - Mild: <2%
  - Moderate: 2-10%
  - Severe: > 10%
  - Very severe: >20%

Pediatrics- AHI

- Normal: < 1.5 events per hour
- Mild: ≥ 1.5 – 5 events per hour
- Moderate: ≥ 5 – 10 events per hour
- Severe: ≥ 10 events per hour

What does effortful breathing look like in kids?

What does sleep apnea look like in kids?

Original Article

The nocturnal-polysomnogram and "non-hypoxic sleep-disordered-breathing" in children

Christian Guilleminault [a, *], Yu-shu Huang [b], Wei-Chih Chin [b], Caroline Okorie [a]

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A R T I C L E I N F O

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Keywords:
Sleep disordered breathing
Upper airway resistance syndrome
Esophageal manometry
Non-hypoxic sleep disordered breathing

A B S T R A C T

Objective: To characterize sleep-disordered breathing patterns not related to hypoxia resulting in fragmented sleep in children.
Methods: We reviewed the polysomnogram (PSG) data of children with sleep complaints who were being evaluated for sleep-disordered breathing and had an apnea-hypopnea-index ≤ 3. These data were compared to the recordings of the same children with nasal CPAP administered for one night and to 60 control subjects (children without any sleep complaints). A subgroup of children was monitored with esophageal manometry, but nasal cannula flow data was recorded in all cases.
Results: Abnormal breathing patterns, particularly flow limitation, could be seen with more severity and frequency compared to apnea or hypopnea. The observed abnormal breathing patterns were associated with EEG disturbances.
Conclusions: Patterns such as flow-limitation, mouth-breathing, changes in inspiratory and expiratory time, rib-cage and expiratory muscle activity, transcutaneous CO2 electrode changes and snoring noises are all variables that should be systematically reviewed when analyzing nocturnal PSG. Current scoring guidelines emphasizes apnea-hypopnea and hypoxic-sleep disordered breathing and therefore treatment is often much delayed in this population of children with evidence of abnormal breathing patterns. Analysis of the various patterns of abnormal breathing noted above allows recognition of "non-hypoxic" sleep-disordered-breathing (SDB).

Video Camera Sleep Screening

➔ **Record a video of your child sleeping.**

Question

- Are all adult patients with AHI < 5 events/hr completely normal?
  - A) YES
  - B) NO

- **Adults- AHI**
  - Normal: < 5 events per hour
  - Mild: ≥ 5 – 15 events per hour
  - Moderate: ≥ 15 – 30 events per hour
  - Severe: ≥ 30 events per hour
  - Very severe: ≥ 60 events per hour

Question

- Are all patients with AHI < 5 events/hr completely normal?
  - A) YES
  - B) NO

There are patients with AHI <5 events/hr who still demonstrate abnormal sleep patterns due to restrictions in the flow of air through the nose or throat areas (upper airway).

Table 1

UARS definitions.

Authors	Clinical criteria	Polysomnographic criteria	
Kristo et al., 2005 [47]	Excessive daytime sleepiness (ESS >10)	Pes≤- 12 cm H_2O	AHI<5/hour, Arousal Index≥10/hour, RERA≥5/hour
Guilleminault et al. [7]	Excessive daytime sleepiness or fatigue	Pes and flow limitation by nasal cannula	AHI<5/hour, RDI>5/hour (RERA), Oxygen saturation>92%
Loube et al., 2009 [48]	Excessive daytime sleepiness	Inductance plethysmogrhaphy Pes≤- 12 cm H_2O	AHI<5/hour and RERA≥10/hour
Stoohs et al., 2009 [49]	Excessive daytime sleepiness or fatigue	Flow limitation by nasal cannula	AHI<5/hour and presence of RERA
Pépin et al., 2012 [6]	Excessive daytime sleepiness	Pes, flow limitation by nasal cannula	RERA as more than 50% of respiratory events

ESS: Epworth Sleepiness Scale, Pes: Esophageal pressure, AHI: Apnea / Hypopnea Index, RERA: Respiratory Event-Related Arousal, RDI: Respiratory Disturbance Index

de Godoy, L.B., Palombini, L.O., Guilleminault, C., Poyares, D., Tufik, S. and Togeiro, S.M., 2015. Treatment of upper airway resistance syndrome in adults: Where do we stand?. *Sleep Science*, *8*(1), pp.42-48.

25 year-old female with excessive daytime sleepiness and fatigue

Sleep Summary

Start Study Time:	1:25:46AM
End Study Time:	8:27:42AM
Total Recording Time:	7 hrs, 1 min
Total Sleep Time	**6 hrs, 17 min**
% REM of Sleep Time:	28.6

Oxygen Saturation Statistics

Mean: 96 Minimum: 94 Maximum: 100

Mean of Desaturations Nadirs (%): 95

Oxygen Desatur. %:	4-9	10-20	>20	Total
Events Number	4	0	0	4
Total	100.0	0.0	0.0	100.0

Oxygen Saturation	<90	<88	<85	<80	<70
Duration (minutes):	0.0	0.0	0.0	0.0	0.0
Sleep %	0.0	0.0	0.0	0.0	0.0

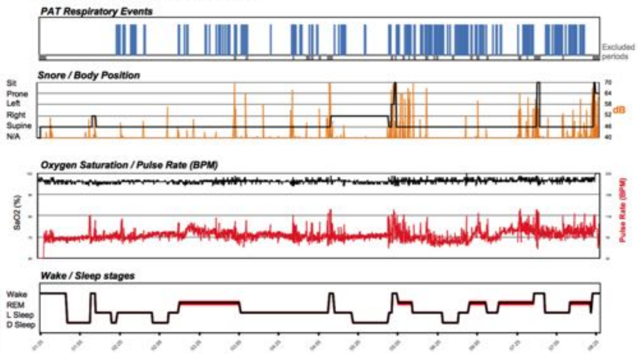
Respiratory Indices

	REM	NREM	All Night
pRDI:	24.7	18.4	**20.2**
pAHI:	5.6	2.0	**3.0**
ODI:	1.1	0.5	**0.6**

Pulse Rate Statistics during Sleep (BPM)

Mean: 80 Minimum: 54 Maximum: 131

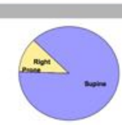
Indices are calculated using technically valid sleep time of 6 hrs, 14 min.
pRDI/pAHI are calculated using oxi desaturations ≥ 3%



Sleep Study Report

Body Position Statistics

Position	Supine	Prone	Right	Left
Sleep (min)	331.9	0.0	45.1	0.0
Sleep %	88.0	0.0	12.0	0.0
pRDI	21.5	N/A	10.7	N/A
pAHI	3.1	N/A	2.7	N/A
ODI	0.7	N/A	0.0	N/A

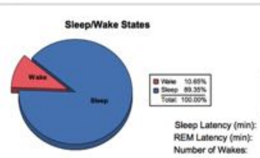


Snoring Statistics

Snoring Level (dB)	>40	>50	>60	>70	>80	>Threshold (45)
Sleep (min)	12.9	3.9	1.4	0.1	0.0	6.5
Sleep %	3.4	1.0	0.4	0.0	0.0	1.7

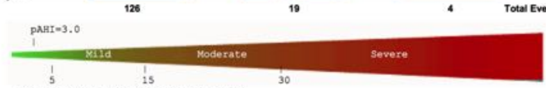
Mean: 40 dB

Sleep Stages Chart



Sleep Latency (min): 19
REM Latency (min): 85
Number of Wakes: 5

Respiratory Indices



* Reference values are according to AASM guidelines

Upper Airway Resistance Syndrome (UARS)

Symptoms

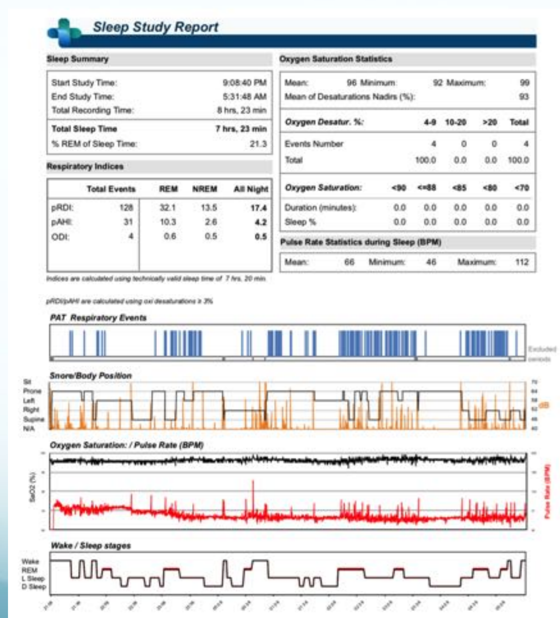
- Difficulty falling asleep
- Restless sleep
- Unrefreshing sleep
- Fatigue, excessive daytime sleepiness
- Mood disturbances
- Anxiety
- Mental stress
- "Fight or Flight"

Sleep Study Findings

- RDI > 10 events/hr
- Arousal index > 10 events/hr
- Other
  - Sleep fragmentation
  - Altered sleep architecture: More than 50% sleep is light sleep (Stage I and II)
  - High sympathetic tone
  - SpO2 cycling
  - Cardiopulmonary coupling

UARS is characterized by sleep fragmentation due to micro-arousals during sleep in association with up-regulation of the sympathetic autonomic nervous system in the setting of resistance to the flow of air through the upper airway during sleep.

Example of UARS characterized as altered sleep architecture and elevated RDI.



Sleep Study Report

Sleep Summary

Start Study Time:	9:08:40 PM
End Study Time:	5:31:48 AM
Total Recording Time:	8 hrs, 23 min
Total Sleep Time	**7 hrs, 23 min**
% REM of Sleep Time:	21.3

Respiratory Indices

	Total Events	REM	NREM	All Night
pRDI:	128	32.1	13.5	**17.4**
pAHI:	31	10.3	2.6	**4.2**
ODI:	4	0.6	0.5	**0.5**

Indices are calculated using technically valid sleep time of 7 hrs, 20 min.

pRDI/pAHI are calculated using oxi desaturations ≥ 3%

Oxygen Saturation Statistics

Mean: 96 Minimum: 92 Maximum: 99

Mean of Desaturations Nadirs (%): 93

Oxygen Desatur. %:	4-9	10-20	>20	Total
Events Number	4	0	0	4
Total	100.0	0.0	0.0	100.0

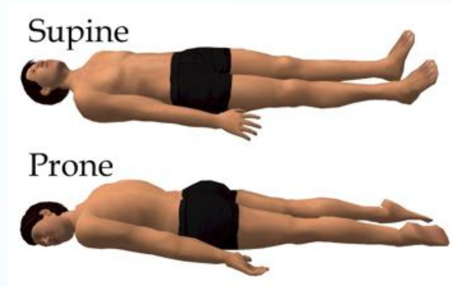
Oxygen Saturation:	<90	<=88	<85	<80	<70
Duration (minutes):	0.0	0.0	0.0	0.0	0.0
Sleep %	0.0	0.0	0.0	0.0	0.0

Pulse Rate Statistics during Sleep (BPM)

Mean: 66 Minimum: 46 Maximum: 112

Positional Sleep Apnea

- Obstructive sleep apnea predominantly or only when patient is in the supine position



25 year-old female with snoring; Epworth Sleepiness Score is 7/24

Sleep Summary

Start Study Time:	8:24:19PM
End Study Time:	6:28:28AM
Total Recording Time:	10 hrs, 4 min
Total Sleep Time	**9 hrs, 18 min**
% REM of Sleep Time:	23.6

Respiratory Indices

	REM	NREM	All Night
pRDI:	5.6	10.9	**9.6**
pAHI:	4.2	9.6	**8.3**
ODI:	1.4	5.5	**4.5**

Indices are calculated using technically valid sleep time of 9 hrs, 14 min.
pRDI/pAHI are calculated using oxi desaturations ≥ 3%

Oxygen Saturation Statistics

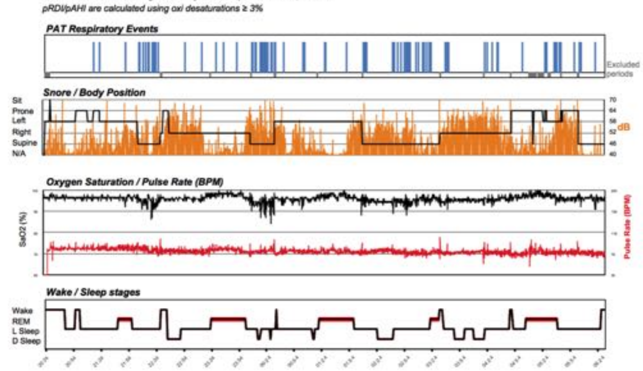
Mean: 96 Minimum: 84 Maximum: 100
Mean of Desaturations Nadirs (%): 91

Oxygen Desatur. %:	4-9	10-20	>20	Total
Events Number	38	4	0	42
Total	90.5	9.5	0.0	100.0

Oxygen Saturation	<90	<88	<85	<80	<70
Duration (minutes):	1.3	0.5	0.0	0.0	0.0
Sleep %	0.2	0.1	0.0	0.0	0.0

Pulse Rate Statistics during Sleep (BPM)

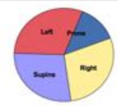
Mean: 81 Minimum: 51 Maximum: 104



Sleep Study Report

Body Position Statistics

Position	Supine	Prone	Right	Left
Sleep (min)	154.6	73.8	160.2	170.0
Sleep %	27.7	13.2	28.7	30.4
pRDI	21.8	3.4	4.9	5.7
pAHI	21.0	1.7	2.6	5.0
ODI	12.8	0.0	1.1	2.1

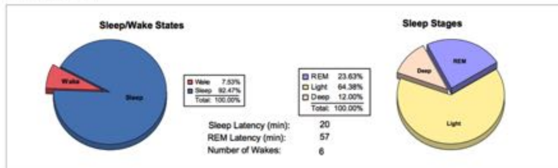


Snoring Statistics

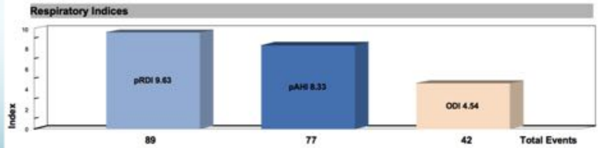
Snoring Level (dB)	>40	>50	>60	>70	>80	>Threshold (45)
Sleep (min)	367.1	142.3	12.5	0.3	0.0	210.7
Sleep %	65.7	25.5	2.2	0.1	0.0	37.7

Mean: 45 dB

Sleep Stages Chart



Respiratory Indices



* Reference values are according to AASM guidelines

51-year-old female with ESS 7/24

Respiratory Indices

	REM	NREM	All Night
pRDI:	5.6	10.9	9.6
pAHI:	4.2	9.6	8.3
ODI:	1.4	5.5	4.5

Other clinical factors
- PMH: Clinical depression
- Meds: Effexor, Wellbutrin, Seroquel, Lamictal
- ROS: Fatigue (FSS 3.2, normal <2.7)
- Nasal obstruction / mouth breathing
- TMJ issues with limited mouth opening
- H/o orthodontic retraction
- PSH: Chin implant

Body Position Statistics

Position	Supine	Prone	Right	Left
Sleep (min)	154.6	73.8	160.2	170.0
Sleep %	27.7	13.2	28.7	30.4
pRDI	21.8	3.4	4.9	5.7
pAHI	21.0	1.7	2.6	5.0
ODI	12.8	0.0	1.1	2.1

Basic Interpretation

Diagnosis: primary snoring or mild sleep apnea

Advanced Interpretation

Diagnosis: moderately severe positional sleep-apnea

Clin Neurophysiol. 2016 Jan;127(1):565-570. doi: 10.1016/j.clinph.2015.06.009. Epub 2015 Jun 16.

Two subtypes of positional obstructive sleep apnea: Supine-predominant and supine-isolated.

Kim KT[1], Cho YW[2], Kim DE[3], Hwang SH[4], Song ML[5], Motamedi GK[6].

⊕ Author information

Abstract

OBJECTIVES: The body position has a strong influence on obstructive sleep apnea (OSA). The purpose of this study is to compare the clinical features of two subtypes of positional OSA (POSA), namely supine-predominant OSA (spOSA) and supine-isolated OSA (siOSA), so as to discuss whether the two groups can be classified separately.

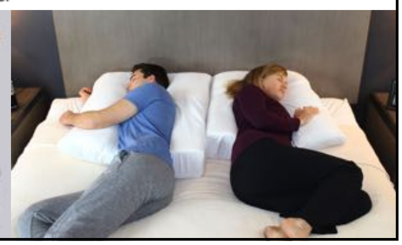
METHODS: A total of 279 consecutive patients with OSA were enrolled. The POSA was defined as having an overall apnea-hypopnea index (AHI) ⩾ 5 with supine AHI > 2 times the non-supine AHI. Only those with ⩾ 30 min spent in the supine and non-supine sleeping positions were included, and split night studies were excluded from the study. Patients were considered spOSA unless their non-supine AHI was negligible (<5) (siOSA). The clinical and polysomnographic characteristics of both groups were compared.

RESULTS: Two hundred and sixteen subjects (77.4%) met the criteria for POSA, with 158 (73.1%) of them classified as spOSA, and 58 (26.9%) as siOSA. The siOSA patients had lower arousal indices, but poorer quality of sleep, and were more depressed and anxious compared with the spOSA subjects.

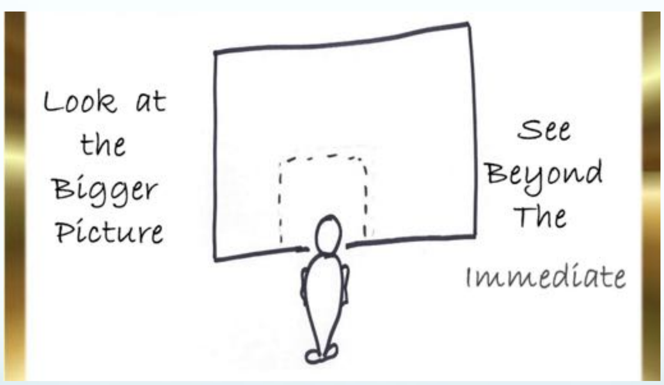
CONCLUSIONS: Those with siOSA and spOSA show different clinical features.

Highlights

- 74% of obstructive sleep apnea (OSA) patients met the criteria for positional OSA (POSA).
- Of those with POSA, 73% have supine-predominant OSA, and 27% supine-isolated OSA.
- The supine-isolated OSA patients have less arousal but poorer sleep quality, and more depression.



Looking at more than just the AHI ...



Oxygen levels, arousals, snoring, body position, sleep-architecture.

Step 4: Evaluate for Other Medical Comorbidities

Table 2. Laboratory Testing for Patients with Unexplained Fatigue

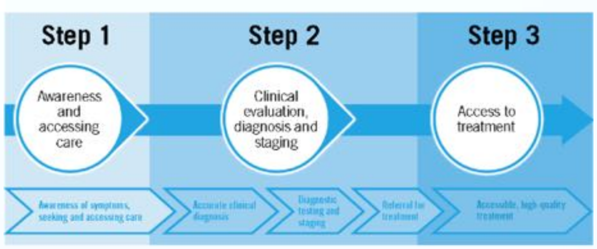
*Test**	*Possible conditions*	*Comments*
Complete blood count	Anemia	Should be performed in most patients with a two-week history of fatigue; results change management in 5 percent of patients[12]
Erythrocyte sedimentation rate	Inflammatory state	
Chemistry panel	Liver disease, renal failure, protein malnutrition	
Thyroid function tests	Hypothyroidism	
Human immunodeficiency virus antibodies	Chronic infection, if not previously tested	
Pregnancy test, if indicated	Pregnancy, breathlessness due to progestins	
Chest radiography	Adenopathy, cancer	Rarely useful; consider only if indicated by physical findings or abnormal baseline blood test results
Tuberculin skin test	Tuberculosis, chronic infection	
Electrocardiography	Congestive heart failure, arrhythmia	
Pulmonary function tests	Chronic obstructive pulmonary disease, cancer	
Toxicology screen	Substance abuse	
Lyme titers	Chronic Lyme disease	
Rapid plasma reagin	Syphilis infection	
Brain magnetic resonance imaging	Multiple sclerosis	
Echocardiography	Valvular heart disease, congestive heart failure	
Specialized blood testing (e.g., ferritin, iron, vitamin B_{12}, and folate levels; iron-binding capacity; direct antiglobulin test)	Iron deficiency, Addison disease, celiac disease, myasthenia gravis, poisoning	

—Arranged by the relative frequency that the tests produce results.

Information from references 10 through 12.

* Needs medical attention*

Importance of *Thorough* Evaluation & Management



46 y/o overweight female with almost 2 years of chronic left-sided lower back pain

- Recommended ice, stretches, exercises
- Massage, chiropractor
- Ibuprofen, pain patches
- Weight-loss

Pain worsened … MRI of her spine

- MRI shows Stage 4 Kidney Cancer
- Labs revealed elevated creatinine
- She had blood in her urine attributed to UTI / kidney stones

Part 2. Treatment Protocols-

Soroush Zaghi, MD
Sleep Surgeon
Otolaryngology (ENT): Sleep and Breathing

DrZ@ZaghiMD.com
www.ZaghiMD.com

Name : TRIBBIANI, JOEY	Project : APNEALINK
Hospital # : Season 4, Ep 20	Subject Code : 082015AFAPNEALINK
Study Date : 08-20-15	Height : 175.2 cm.
Sex: Male	Weight: 75 kg.
Age : 28	B.M.I. : 24.5 kg/ m^2

Out-Of-Center Study Testing for Sleep-Related Breathing Disorders

AHI [1]	15.8
Oxygen Desaturation Index (>=3%) [2]	6.7
Minimum Oxygen Saturation (%)	89.0
Total Recording Time (minutes)	434.2

[1]The Apnea Hypopnea Index (AHI) represents the number of abnormal respiratory events per hour of recording. Abnormal respiratory events comprise of obstructive/central/mixed apneas and modified hypopneas. Of note, the modified hypopnea describes events lasting ≥ 10 seconds of 30% or more reduction in airflow as measured by the nasal cannula flow signal amplitude, and associated with a 3% oxygen desaturation. Definitions of various abnormal respiratory events can be found in the 2012 American Academy of Sleep Medicine (AASM) manual.

[2]The Oxygen Desaturation Index (ODI) is the number of times oxygen saturation drops by 3% or more (from baseline) per hour of recording.

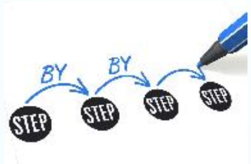
The OOC study does not include certain channels such as electroencephalographic (EEG) channel, electrooculographic (EOC) channel, snoring channel, or limb leads. It will not report data such as various stages of sleep, respiratory events associated with EEG arousal, snoring, or body movements. It will not capture all types of abnormal respiratory events.

Sleep Disordered Breathing: Treatment Tool Box (Adults)

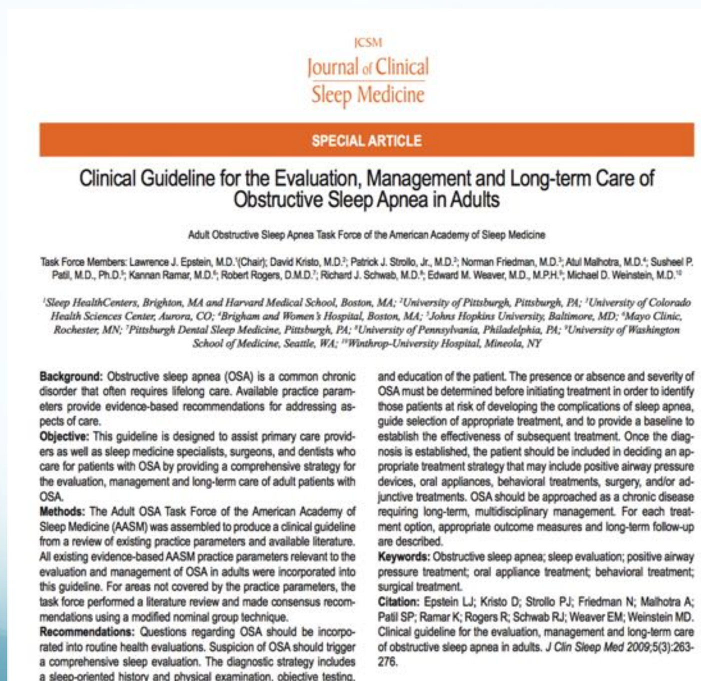
- Oral Appliances
- CPAP
- Myofunctional
- ENT Surgical
- OMFS Surgical
- Orthodontic / Dental Orthopedic

Treatment Options:
What should we do?

- **Guidelines Approach**



- **Individualized**
  - **Functional - Structural Approach**



JCSM
Journal of Clinical Sleep Medicine

SPECIAL ARTICLE

Clinical Guideline for the Evaluation, Management and Long-term Care of Obstructive Sleep Apnea in Adults

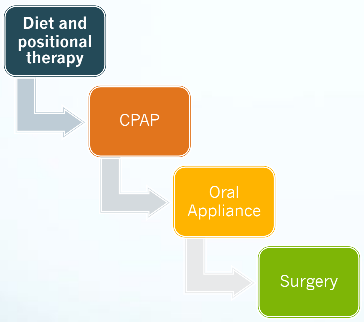
Adult Obstructive Sleep Apnea Task Force of the American Academy of Sleep Medicine

Task Force Members: Lawrence J. Epstein, M.D.[1](Chair); David Kristo, M.D.[2]; Patrick J. Strollo, Jr., M.D.[3]; Norman Friedman, M.D.[3]; Atul Malhotra, M.D.[4]; Susheel P. Patil, M.D., Ph.D.[5]; Kannan Ramar, M.D.[6]; Robert Rogers, D.M.D.[7]; Richard J. Schwab, M.D.[8]; Edward M. Weaver, M.D., M.P.H.[9]; Michael D. Weinstein, M.D.[10]

[1]Sleep HealthCenters, Brighton, MA and Harvard Medical School, Boston, MA; [2]University of Pittsburgh, Pittsburgh, PA; [3]University of Colorado Health Sciences Center, Aurora, CO; [4]Brigham and Women's Hospital, Boston, MA; [5]Johns Hopkins University, Baltimore, MD; [6]Mayo Clinic, Rochester, MN; [7]Pittsburgh Dental Sleep Medicine, Pittsburgh, PA; [8]University of Pennsylvania, Philadelphia, PA; [9]University of Washington School of Medicine, Seattle, WA; [10]Winthrop-University Hospital, Mineola, NY

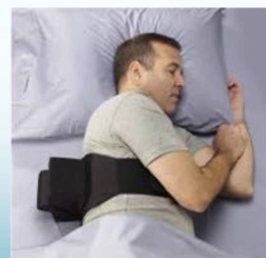
Background: Obstructive sleep apnea (OSA) is a common chronic disorder that often requires lifelong care. Available practice parameters provide evidence-based recommendations for addressing aspects of care.
Objective: This guideline is designed to assist primary care providers as well as sleep medicine specialists, surgeons, and dentists who care for patients with OSA by providing a comprehensive strategy for the evaluation, management and long-term care of adult patients with OSA.
Methods: The Adult OSA Task Force of the American Academy of Sleep Medicine (AASM) was assembled to produce a clinical guideline from a review of existing practice parameters and available literature. All existing evidence-based AASM practice parameters relevant to the evaluation and management of OSA in adults were incorporated into this guideline. For areas not covered by the practice parameters, the task force performed a literature review and made consensus recommendations using a modified nominal group technique.
Recommendations: Questions regarding OSA should be incorporated into routine health evaluations. Suspicion of OSA should trigger a comprehensive sleep evaluation. The diagnostic strategy includes a sleep-oriented history and physical examination, objective testing, and education of the patient. The presence or absence and severity of OSA must be determined before initiating treatment in order to identify those patients at risk of developing the complications of sleep apnea, guide selection of appropriate treatment, and to provide a baseline to establish the effectiveness of subsequent treatment. Once the diagnosis is established, the patient should be included in deciding an appropriate treatment strategy that may include positive airway pressure devices, oral appliances, behavioral treatments, surgery, and/or adjunctive treatments. OSA should be approached as a chronic disease requiring long-term, multidisciplinary management. For each treatment option, appropriate outcome measures and long-term follow-up are described.
Keywords: Obstructive sleep apnea; sleep evaluation; positive airway pressure treatment; oral appliance treatment; behavioral treatment; surgical treatment.
Citation: 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.*

Guidelines Approach: "Step by Step"



Step One

- Reduce alcohol consumption
- Weight loss
- Positional therapy
- Chin strap



The influence of head-of-bed elevation in patients with obstructive sleep apnea

Fábio José Fabrício de Barros Souza[1] **· Pedro Rodrigues Genta**[2] **·**
Albino José de Souza Filho[3] **· Andrew Wellman**[4] **· Geraldo Lorenzi-Filho**[2]

Received: 7 February 2017 / Revised: 21 May 2017 / Accepted: 31 May 2017 / Published online: 24 June 2017

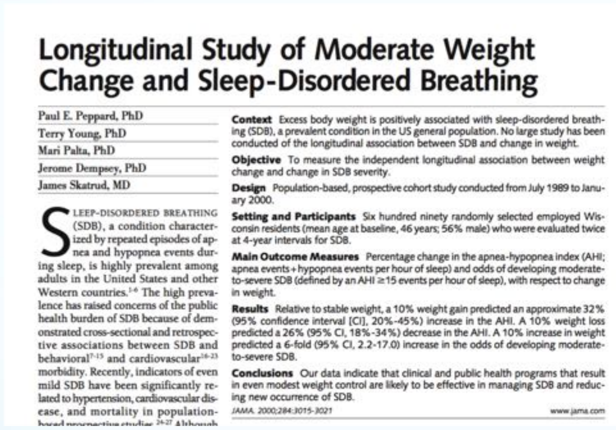
Abstract
Purpose The purpose of this study is to test the effects of a mild degree of head-of-bed elevation (HOBE) (7.5°) on obstructive sleep apnea (OSA) severity and sleep quality.
Methods OSA patients were recruited from a single sleep clinic (Criciúma, Santa Catarina, Brazil). Following a baseline polysomnography (PSG), all patients underwent a PSG with HOBE (within 2 weeks). In addition, a subset of patients performed a third PSG without HOBE.
Results Fifty-two patients were included in the study (age 53.2 ± 9.1 years; BMI 29.6 ± 4.8 kg/m^2, neck circumference 38.9 ± 3.8 cm, and Epworth Sleepiness Scale 15 ± 7). Compared to baseline, HOBE significantly decreased the apnea-hypopnea index (AHI) from 15.7 [11.3–22.5] to 10.7 [6.6–16.5] events/h; $p < 0.001$ and increased minimum oxygen saturation from 83.5 [77.5–87] to 87 [81–90]%; $p = 0.003$. The sleep architecture at baseline and HOBE were similar. However, sleep efficiency increased slightly but significantly with HOBE (87.2 [76.7–90.7] vs 88.8 [81.6–93.3]; $p = 0.005$). The AHI obtained at the third PSG without HOBE ($n = 7$) returned to baseline values.
Conclusions Mild HOBE significantly improves OSA severity without interfering in sleep architecture and therefore is a simple alternative treatment to ameliorate OSA.

Keywords Obstructive sleep apnea · Therapy · Patient positioning · Polysomnography

Introduction

Obstructive sleep apnea (OSA) is a common disorder characterized by repetitive partial or complete obstruction of the upper airway during sleep [1–3]. The pathophysiology of OSA is complex and is caused by the interplay of both anatomical and non-anatomical factors including neuromuscular responsiveness, ventilatory instability, and arousal threshold [3]. Continuous positive airway pressure (CPAP) is the most common treatment for OSA. However, CPAP adherence is not ideal and may be even worse among subjects with milder forms of OSA [4, 5].

Alternative options for OSA treatment include oral appliances, upper airway surgery, oropharyngeal exercises, and positional therapy [6–12]. Head-of-bed elevation (HOBE) has



Longitudinal Study of Moderate Weight Change and Sleep-Disordered Breathing

Paul E. Peppard, PhD
Terry Young, PhD
Mari Palta, PhD
Jerome Dempsey, PhD
James Skatrud, MD

Context Excess body weight is positively associated with sleep-disordered breathing (SDB), a prevalent condition in the US general population. No large study has been conducted of the longitudinal association between SDB and change in weight.

Objective To measure the independent longitudinal association between weight change and change in SDB severity.

Design Population-based, prospective cohort study conducted from July 1989 to January 2000.

Setting and Participants Six hundred ninety randomly selected employed Wisconsin residents (mean age at baseline, 46 years; 56% male) who were evaluated twice at 4-year intervals for SDB.

Main Outcome Measures Percentage change in the apnea-hypopnea index (AHI; apnea events + hypopnea events per hour of sleep) and odds of developing moderate-to-severe SDB (defined by an AHI ≥15 events per hour of sleep), with respect to change in weight.

Results Relative to stable weight, a 10% weight gain predicted an approximate 32% (95% confidence interval [CI], 20%-45%) increase in the AHI. A 10% weight loss predicted a 26% (95% CI, 18%-34%) decrease in the AHI. A 10% increase in weight predicted a 6-fold (95% CI, 2.2-17.0) increase in the odds of developing moderate-to-severe SDB.

Conclusions Our data indicate that clinical and public health programs that result in even modest weight control are likely to be effective in managing SDB and reducing new occurrence of SDB.

JAMA. 2000;284:3015-3021 www.jama.com

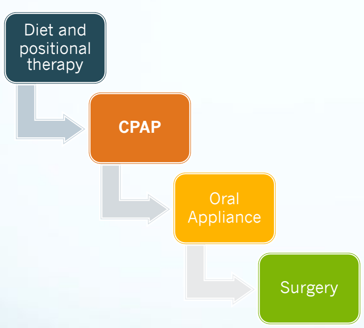
SLEEP-DISORDERED BREATHING (SDB), a condition characterized by repeated episodes of apnea and hypopnea events during sleep, is highly prevalent among adults in the United States and other Western countries.[1-6] The high prevalence has raised concerns of the public health burden of SDB because of demonstrated cross-sectional and retrospective associations between SDB and behavioral[7-15] and cardiovascular[16-23] morbidity. Recently, indicators of even mild SDB have been significantly related to hypertension, cardiovascular disease, and mortality in population-based prospective studies.[24-27] Although

- 10% change in body weight can affect AHI severity of obstructive sleep apnea by 26-32%
-
- 20% change affects the severity by 48-70%.
- Goal BMI <25.0 mg/kg²

Lifestyle changes including a goal of walking 10,000 steps per day and drinking 8x 8-oz glasses of water per day have been shown to be effective in sustaining long-term moderate weight loss.

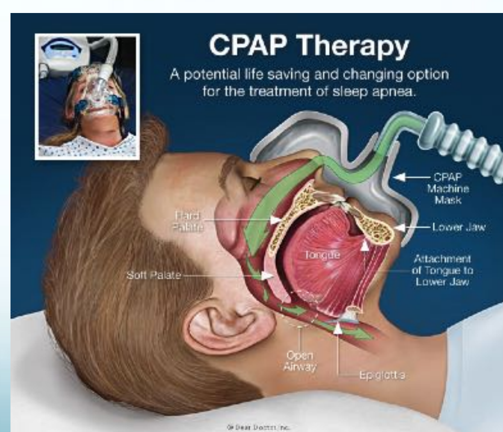
Peppard, Paul E., et al. "Longitudinal study of moderate weight change and sleep-disordered breathing." Journal of American Medical Association 284.23 (2000): 3015-3021.Schneider, Patrick L., et al. "Effects of a 10,000 steps per day goal in overweight adults." American Journal of Health Promotion 21.2 (2006): 85-89.

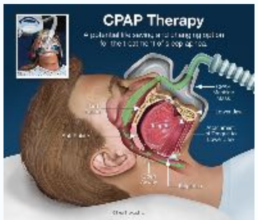
Guidelines Approach: "Step by Step"



Step Two

- CPAP





Continuous Positive Airway Pressure

Credit: Robson Capasso, MD

David- First Morning After CPAP

Long-term cardiovascular outcomes in men with obstructive sleep apnoea-hypopnoea with or without treatment with continuous positive airway pressure: an observational study

Lancet 2005; 365: 1046–53

Jose M Marin, Santiago J Carrizo, Eugenio Vicente, Alvar G N Agusti

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Correspondence to: Dr Jose M Marin, Servicio de Neurologia, Hospital Universitario Miguel Servet, Isabel la Catolica, 50006 Zaragoza, Spain jmmarint@unizar.es

Summary

Background The effect of obstructive sleep apnoea-hypopnoea as a cardiovascular risk factor and the potential protective effect of its treatment with continuous positive airway pressure (CPAP) is unclear. We did an observational study to compare incidence of fatal and non-fatal cardiovascular events in simple snorers, patients with untreated obstructive sleep apnoea-hypopnoea, patients treated with CPAP, and healthy men recruited from the general population.

Methods We recruited men with obstructive sleep apnoea-hypopnoea or simple snorers from a sleep clinic, and a population-based sample of healthy men, matched for age and body-mass index with the patients with untreated severe obstructive sleep apnoea-hypopnoea. The presence and severity of the disorder was determined with full polysomnography, and the apnoea-hypopnoea index (AHI) was calculated as the average number of apnoeas and hypopnoeas per hour of sleep. Participants were followed-up at least once per year for a mean of 10·1 years (SD 1·6) and CPAP compliance was checked with the built-in meter. Endpoints were fatal cardiovascular events (death from myocardial infarction or stroke) and non-fatal cardiovascular events (non-fatal myocardial infarction, non-fatal stroke, coronary artery bypass surgery, and percutaneous transluminal coronary angiography).

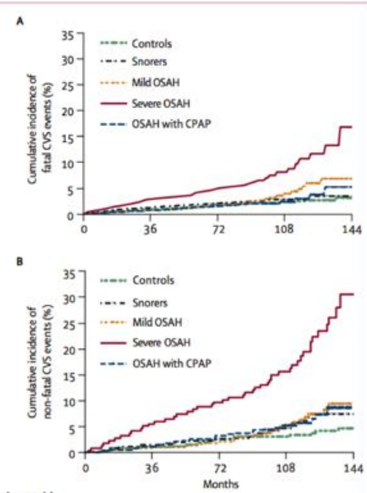
Findings 264 healthy men, 377 simple snorers, 403 with untreated mild-moderate obstructive sleep apnoea-hypopnoea, 235 with untreated severe disease, and 372 with the disease and treated with CPAP were included in the analysis. Patients with untreated severe disease had a higher incidence of fatal cardiovascular events (1·06 per 100 person-years) and non-fatal cardiovascular events (2·13 per 100 person-years) than did untreated patients with mild-moderate disease (0·55, p=0·02 and 0·89, p<0·0001), simple snorers (0·34, p=0·0006 and 0·58, p<0·0001), patients treated with CPAP (0·35, p=0·0008 and 0·64, p<0·0001), and healthy participants (0·3, p=0·0012 and 0·45, p<0·0001). Multivariate analysis, adjusted for potential confounders, showed that untreated severe obstructive sleep apnoea-hypopnoea significantly increased the risk of fatal (odds ratio 2·87, 95%CI 1·17–7·51) and non-fatal (3·17, 1·12–7·51) cardiovascular events compared with healthy participants.

Interpretation In men, severe obstructive sleep apnoea-hypopnoea significantly increases the risk of fatal and non-fatal cardiovascular events. CPAP treatment reduces this risk.

Significantly higher incidence of fatal and non-fatal cardiovascular events in patients with untreated severe obstructive sleep apnea.

Furthermore, there seems to be a dose-effect relation for this association.

Treatment with CPAP significantly reduces this risk.



Numbers at risk

Controls	264	262	259	258
Snorers	377	372	361	232
Mild OSAH	403	401	392	264
Severe OSAH	235	229	221	167
OSAH with CPAP	372	364	361	229

Figure 2: Cumulative percentage of individuals with new fatal (A) and non-fatal (B) cardiovascular events in each of the five groups studied

CPAP does not reduce cardiovascular risk…..

….if the patient does not use it.

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

CPAP for Prevention of Cardiovascular Events in Obstructive Sleep Apnea

R. Doug McEvoy, M.D., Nick A. Antic, M.D., Ph.D., Emma Heeley, Ph.D., Yuanming Luo, M.D., Qiong Ou, M.D., Xilong Zhang, M.D., Olga Mediano, M.D., Rui Chen, M.D., Luciano F. Drager, M.D., Ph.D., Zhihong Liu, M.D., Ph.D., Guofang Chen, M.D., Baoliang Du, M.D., Nigel McArdle, M.D., Sutapa Mukherjee, M.D., Ph.D., Manjari Tripathi, M.D., Laurent Billot, M.Sc., Qiang Li, M.Biostat., Geraldo Lorenzi-Filho, M.D., Ferran Barbe, M.D., Susan Redline, M.D., M.P.H., Jiguang Wang, M.D., Ph.D., Hisatomi Arima, M.D., Ph.D., Bruce Neal, M.D., Ph.D., David P. White, M.D., Ron R. Grunstein, M.D., Ph.D., Nanshan Zhong, M.D., and Craig S. Anderson, M.D., Ph.D., for the SAVE Investigators and Coordinators*

ABSTRACT

BACKGROUND

Obstructive sleep apnea is associated with an increased risk of cardiovascular events; whether treatment with continuous positive airway pressure (CPAP) prevents major cardiovascular events is uncertain.

METHODS

After a 1-week run-in period during which the participants used sham CPAP, we randomly assigned 2717 eligible adults between 45 and 75 years of age who had moderate-to-severe obstructive sleep apnea and coronary or cerebrovascular disease to receive CPAP treatment plus usual care (CPAP group) or usual care alone (usual-care group). The primary composite end point was death from cardiovascular causes, myocardial infarction, stroke, or hospitalization for unstable angina, heart failure, or transient ischemic attack. Secondary end points included other cardiovascular outcomes, health-related quality of life, snoring symptoms, daytime sleepiness, and mood.

RESULTS

Most of the participants were men who had moderate-to-severe obstructive sleep apnea and minimal sleepiness. In the CPAP group, the mean duration of adherence to CPAP therapy was 3.3 hours per night, and the mean apnea–hypopnea index (the number of apnea or hypopnea events per hour of recording) decreased from 29.0 events per hour at baseline to 3.7 events per hour during follow-up. After a mean follow-up of 3.7 years, a primary end-point event had occurred in 229 participants in the CPAP group (17.0%) and in 207 participants in the usual-care group (15.4%) (hazard ratio with CPAP, 1.10; 95% confidence interval, 0.91 to 1.32; P=0.34). No significant effect on any individual or other composite cardiovascular end point was observed. CPAP significantly reduced snoring and daytime sleepiness and improved health-related quality of life and mood.

CONCLUSIONS

Therapy with CPAP plus usual care, as compared with usual care alone, did not prevent cardiovascular events in patients with moderate-to-severe obstructive sleep apnea and established cardiovascular disease. (Funded by the National Health and Medical Research Council of Australia and others; SAVE ClinicalTrials.gov number, NCT00738179; Australian New Zealand Clinical Trials Registry number, ACTRN12608000409370.)

The authors' affiliations are listed in the Appendix. Address reprint requests to Dr. McEvoy at the Adelaide Institute for Sleep Health, Flinders University and Respiratory and Sleep Services, Southern Adelaide Local Health Network, Repatriation General Hospital, Daw Park, Adelaide SA 5041, Australia, or at doug.mcevoy@flinders.edu.au; or to Dr. Luo at the First Affiliated Hospital of Guangzhou Medical University, State Key Laboratory of Respiratory Disease, Guangzhou, China, or at yuanmingluo9431@yahoo.co.uk.

*A complete list of sites and trial investigators and coordinators in the Sleep Apnea Cardiovascular Endpoints (SAVE) study is provided in the Supplementary Appendix, available at NEJM.org.

This article was published on August 28, 2016, at NEJM.org.

DOI: 10.1056/NEJMoa1606599

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The Washington Post

To Your Health

Did sleep apnea contribute to Justice Scalia's death? His unplugged breathing machine raises that question.

By Ariana Eunjung Cha February 24, 2016

U.S. Supreme Court justice Antonin Scalia was known for the exacting style of his opinions, the way he labored over each and every word. His hotel room the night of his death on Feb. 13 in Texas reflected this obsession with detail. According to a sheriff's report obtained by The Washington Post this week, he was lying in bed with his arms at his side and his bed covers smooth. Nearby was his suitcase, which was open and full of neatly folded clothes.

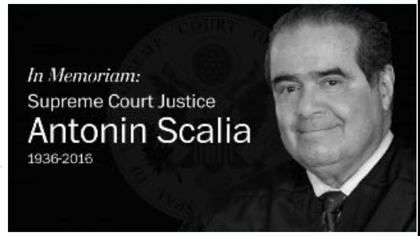
Only one thing appeared amiss: a breathing apparatus. The small device, called a Continuous Positive Airway Pressure (CPAP) machine, was on the nightstand next to him — but unplugged and not turned on.

The finding has sparked speculation that Scalia may have forgotten to use it that night.

The cause of his death hasn't been definitively given but the Presidio County Sheriff's Office has said there's no evidence of foul play and his doctor has noted that the former justice had numerous serious health problems, including heart disease, diabetes and high blood pressure.

Scalia was one of an estimated 22 million Americans who have sleep apnea, a potentially life-threatening condition caused by either a blockage of the airway or a signaling issue from the brain regarding breathing during sleep. This can cause someone to stop breathing — for a second, a minute or more — up to hundreds of times each night.

The most commonly used treatment is a CPAP, which consists of a machine that supplies steady air pressure, a hose and either a mask or nose piece that regulates breathing. Many doctors liken CPAP machines to blood pressure medications. That is, they should be used as regularly as possible but they do provide some benefit even if they aren't in use. Experts say the chance of death from skipping a single day is tiny, and patients can and do take breaks because they have a cold, forget to take the machine on a short trip or because the masks are irritating. Typically the only immediate ill effects are snoring and possibly getting up at night gasping.



Limitations

- CPAP: ~50 % of patients cannot tolerate treatment
- And among those that do agree to CPAP:
  - Median compliance rate (at least 4 hours per night): 46%.
  - Average time used: 4.88 +1.9 hrs per night.
  - Compliant patients attempt to use CPAP: 2 of every 3 nights.

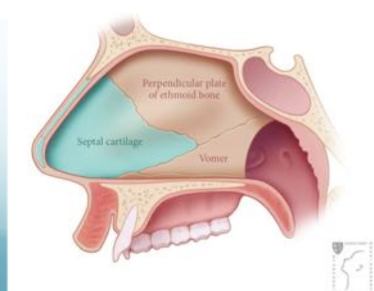
➔ CPAP use by OSA patients falls short of the therapeutic goal of providing quality sleep all night, every night.

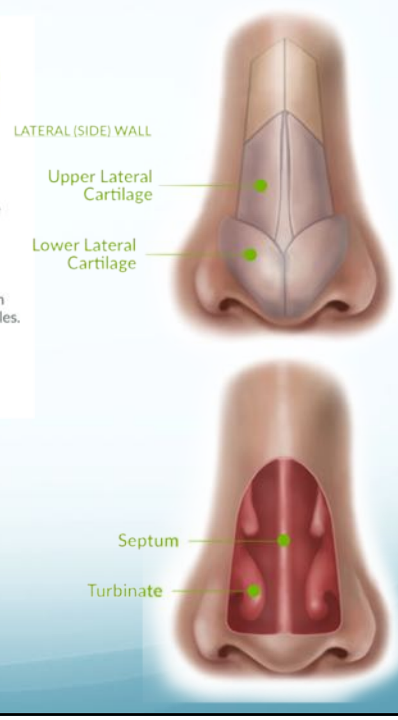
What Causes Nasal Airway Obstruction?

Even slight narrowing of the nasal valve can lead to significant reduction in airflow[4,5,6]. Structural blockages in three areas are common:

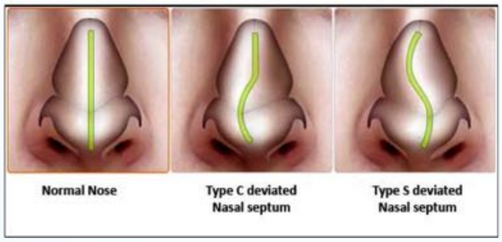
- **Septum:** The cartilage wall between the nostrils can bend and block the nasal passage.
- **Turbinates:** Ridges of bone and tissue inside the nose can limit airflow when enlarged.
- **Lateral (side) wall:** Weak or excessively flexible upper/lower cartilage in the outer nasal wall may cause it to collapse inward when a person inhales.

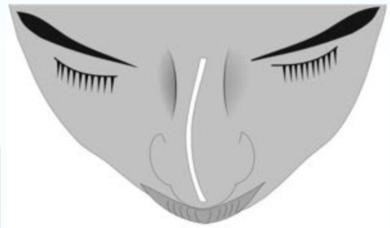
Lateral wall collapse may equal or even exceed septal deviation as the prime cause of nasal airway obstruction[7,8].



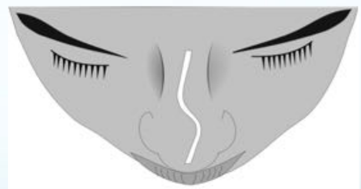


Septal Deviation

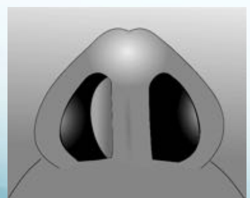


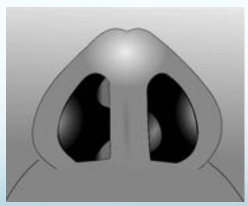


Anteroposterior dimension: C-shaped.



Anteroposterior dimension: S-shaped.

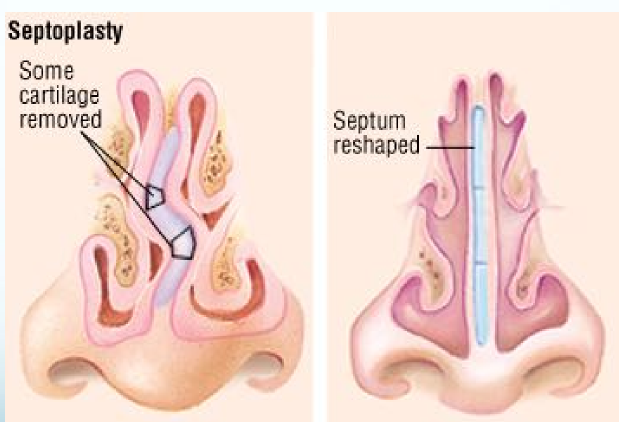




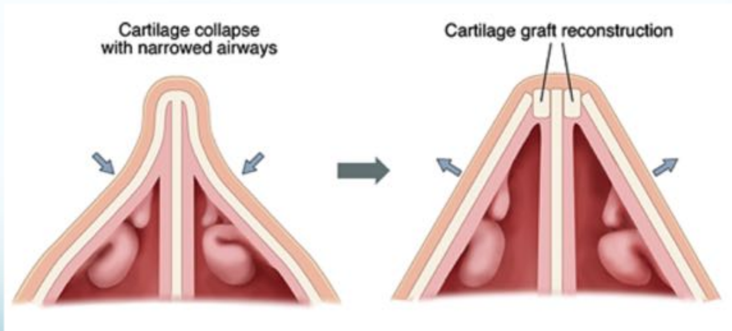
Cephalocaudal: C- shaped deviation S- shaped deviation

Note: Reverse S-shaped / Reverse C-shaped would be the mirror images.

Septoplasty

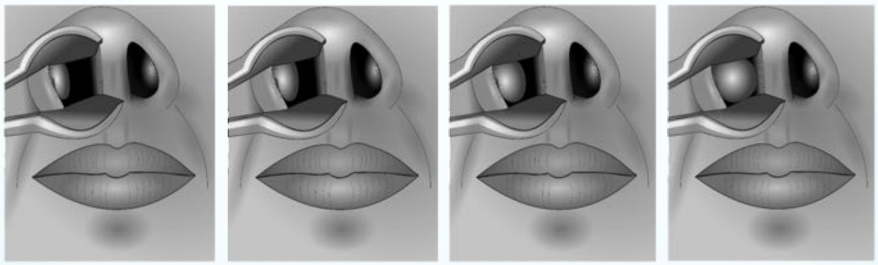


Septoplasty with Nasal Valve Repair Using Spreader Grafts



Septoplasty with Nasal Valve Repair

Inferior Turbinate

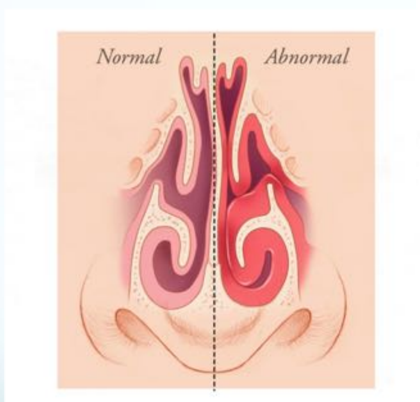


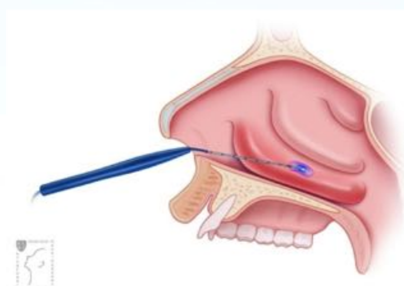
Grade 1
(0-25% of total airway space)

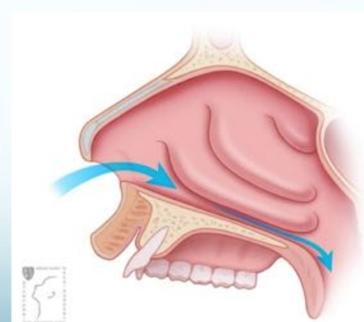
Grade 2
(26-50% of total airway space)

Grade 3
(51-75% of total airway space)

Grade 4
(76-100% of total airway space)





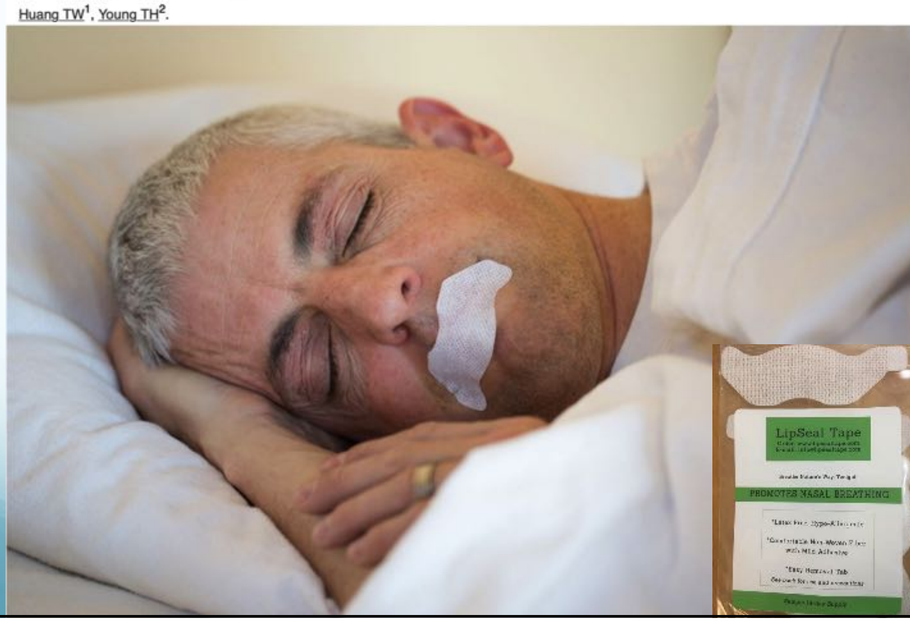


Adjustable Chin Strap: Keeps Mouth Shut at Night

Otolaryngol Head Neck Surg. 2015 Feb;152(2):369-73. doi: 10.1177/0194599814559383. Epub 2014 Dec 1.

Novel porous oral patches for patients with mild obstructive sleep apnea and mouth breathing: a pilot study.

Huang TW[1], Young TH[2].



Functional Approach

Sleep Breath
DOI 10.1007/s11325-016-1429-6

SLEEP BREATHING PHYSIOLOGY AND DISORDERS • ORIGINAL ARTICLE

Myofunctional therapy improves adherence to continuous positive airway pressure treatment

Giovana Diaféria[1] · Rogerio Santos-Silva[1] · Eveli Truksinas[1] · Fernanda L. M. Haddad[1,2] · Renata Santos[1] · Silvana Bommarito[3] · Luiz C. Gregório[2] · Sergio Tufik[1] · Lia Bittencourt[1]

Received: 9 August 2015 / Revised: 17 October 2016 / Accepted: 27 October 2016

Abstract

Purpose Few studies have investigated myofunctional therapy in patients with obstructive sleep apnea syndrome (OSAS). The objective of this study was to evaluate the effect of myofunctional therapy on continuous positive airway pressure (CPAP) adherence.

Methods The study was registered at ClinicalTrials.gov (NCT01289405). Male patients with OSAS were randomly divided into four treatment groups: placebo, patients undergoing placebo myofunctional therapy ($N = 24$); myofunctional therapy, undergoing myofunctional therapy ($N = 27$); CPAP, undergoing treatment with CPAP ($N = 27$); and combined, undergoing CPAP therapy and myofunctional therapy ($N = 22$). All patients underwent evaluations before and after 3 months of treatment evaluation and after 3 weeks of washout. Evaluations included Epworth sleepiness scale (ESS), polysomnography, and myofunctional evaluation.

Results The 100 men had a mean age of 48.1 ± 11.2 years, body mass index of 27.4 ± 4.9 kg/m^2, ESS score of 12.7 ± 3.0, and apnea-hypopnea index (AHI) of 30.9 ± 20.6. All treated groups (myofunctional therapy, CPAP, and combined myofunctional therapy with CPAP) showed decreased ESS and snoring, and the myofunctional therapy group maintained this improvement after the "washout" period. AHI reduction occurred in all treated groups and was more significant in CPAP group. The myofunctional therapy and combined groups showed improvement in tongue and soft palate muscle strength when compared with the placebo group. The association of myofunctional therapy to CPAP (combined group) showed an increased adherence to CPAP compared with the CPAP group.

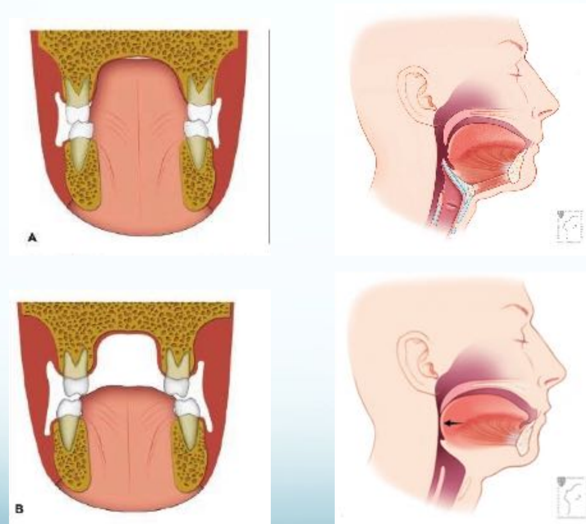
Conclusions Our results suggest that in patients with OSAS, myofunctional therapy may be considered as an adjuvant treatment and an intervention strategy to support adherence to CPAP.

Keywords Obstructive sleep apnea · Treatment · Myofunctional therapy · Continuous positive airway pressure · Polysomnography

Introduction

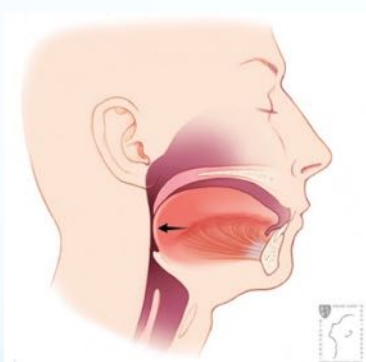
Obstructive sleep apnea syndrome (OSAS) is a disease with multifactorial pathways of pathophysiology that involve anatomical and functional pharyngeal changes [1, 2]. Although the treatment of choice is the continuous positive airway pressure (CPAP) device, adherence to this type of therapy has been

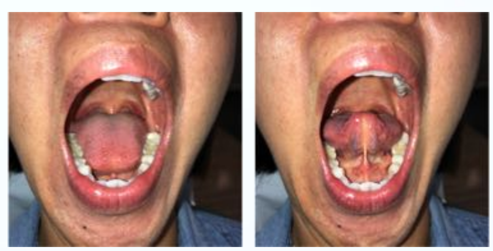
Principle of Proper Tongue Positioning: Tongue should rest completely at the roof of the mouth to maintain optimal airway function.



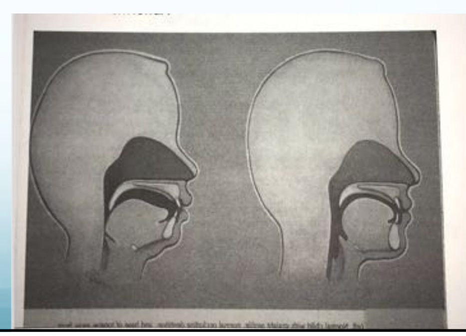
Tongue loses tone and assumes a posterior – inferior position in the airway.

Tongue-tie may interfere with tongue mobility and range of motion.

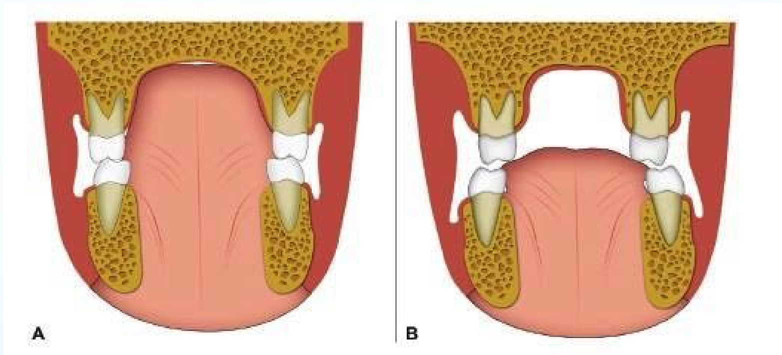




Tongue assumes low position; may block the airway awake and during deep sleep.

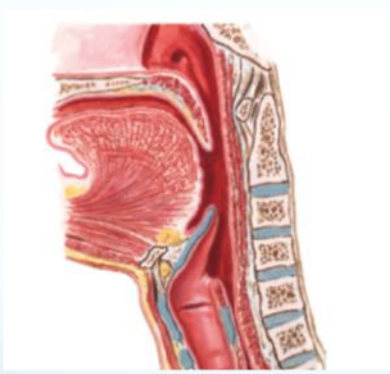


- **Goal: Tongue up on the palate**
- **Dysfunction: Low Tongue Posture**

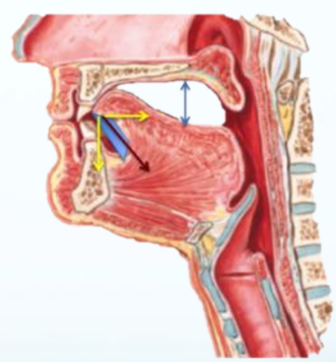


Tongue should rest up at the roof of the palate to maintain optimal airway function.

Ideal Tongue Position: tongue suctioned up to the roof of mouth



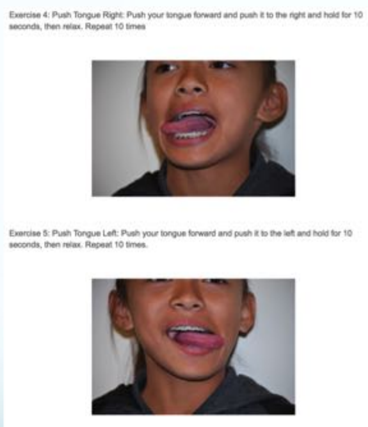
Normal / Optimal
Wide Open Airway

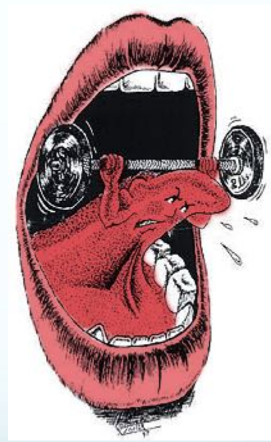


Low Tongue Posture
Tongue blocking airway

Reference Credit: http://www.paragonhealth.net.au/blog/tongue-tie-in-adults

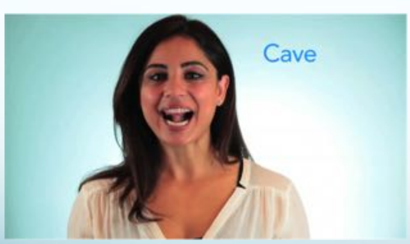
Myofunctional Therapy





Oral myofunctional therapy is an individualized program of isometric (static) and isotonic (dynamic) strength and pattern retraining exercises of the tongue and orofacial muscles (for patients with sleep, teeth-grinding, breathing, posture, orthodontic relapse, cervical neck tension, and/or jaw pain issues) to correct maladaptive oral habits and help restore ideal resting oral posture.

Myofunctional Therapy



Goals and Objectives

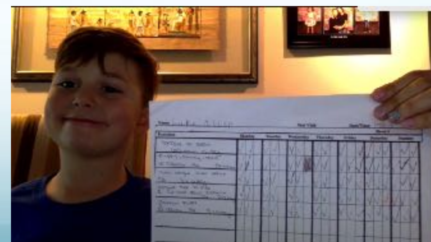
1. *Promote exclusive nasal breathing.*
2. *Strengthen and tone the muscles of the tongue and orofacial complex.*
3. *Promote ideal resting oral posture (lips together, tongue on the roof of the mouth, nasal breathing).*
4. *Among others…..*
   Alleviating pain and dysfunction by identifying compensations of the jaw and neck during chewing, talking, swallowing.

MYOFUNCTIONAL THERAPY TO TREAT OSA: REVIEW AND META-ANALYSIS

Myofunctional Therapy to Treat Obstructive Sleep Apnea: A Systematic Review and Meta-analysis

Macario Camacho, MD[1]; Victor Certal, MD[2]; Jose Abdullatif, MD[3]; Soroush Zaghi, MD[4]; Chad M. Ruoff, MD, RPSGT[1]; Robson Capasso, MD[5]; Clete A. Kushida, MD, PhD[1]

1. Myofunctional therapy provides a reduction in AHI of approximately 50% in adults and 62% in children.
2. Improvements to daytime sleepiness and snoring.
3. Shown effective in children and adults of all ages studied thus far.
   Youngest patient: 3 years old
   Oldest patient: 79+ years old.
4. Important role in preventing relapse.



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Nature and Science of Sleep

Dovepress
open access to scientific and medical research

Open Access Full Text Article

REVIEW

Obstructive sleep apnea: focus on myofunctional therapy

This article was published in the following Dove Press journal:
Nature and Science of Sleep

Cláudia Maria de Felício[1,2]
Franciele Voltarelli da Silva Dias[1,2]
Luciana Vitaliano Voi Trawitzki[1,2]

[1]Department of Ophthalmology, Otorhinolaryngology and Head and Neck Surgery, School of Medicine of Ribeirão Preto, University of São Paulo, Ribeirão Preto, Brazil; [2]Craniofacial Research Support Center, University of São Paulo (USP), Ribeirão Preto, Brazil

Purpose: Orofacial myofunctional therapy (OMT) is a modality of treatment for children and adults with obstructive sleep apnea (OSA) to promote changes in the musculature of the upper airways. This review summarizes and discusses the effects of OMT on OSA, the therapeutic programs employed, and their possible mechanisms of action.

Methods: We conducted an online literature search using the databases MEDLINE/PubMed, EMBASE, and Web of Science. Search terms were "obstructive sleep apnea" in combination with "myofunctional therapy" OR "oropharyngeal exercises" OR "speech therapy". We considered original articles in English and Portuguese containing a diagnosis of OSA based on polysomnography (PSG). The primary outcomes of interest for this review were objective measurement derived from PSG and subjective sleep symptoms. The secondary outcome was the evaluation of orofacial myofunctional status.

Results: Eleven studies were included in this review. The studies reviewed reveal that several benefits of OMT were demonstrated in adults, which include significant decrease of apnea–hypopnea index (AHI), reduced arousal index, improvement in subjective symptoms of daytime sleepiness, sleep quality, and life quality. In children with residual apnea, OMT promoted a decrease of AHI, increase in oxygen saturation, and improvement of orofacial myofunctional status. Few of the studies reviewed reported the effects of OMT on the musculature.

Conclusion: The present review showed that OMT is effective for the treatment of adults in reducing the severity of OSA and snoring, and improving the quality of life. OMT is also successful for the treatment of children with residual apnea. In addition, OMT favors the adherence to continuous positive airway pressure. However, randomized and high-quality studies are still rare, and the effects of treatment should also be analyzed on a long-term basis, including measures showing if changes occurred in the musculature.

Keywords: sleep-disordered breathing, myofunctional therapy, oropharyngeal exercises, speech therapy, oral motor exercises

Tongue - Tie

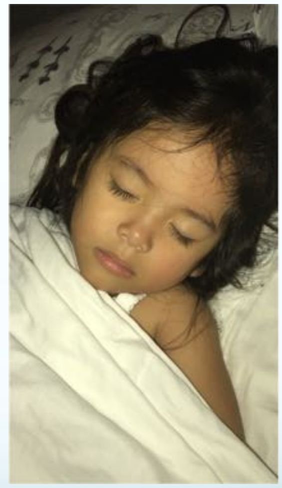
Animation Credit:
Nathan Devery and Nora Ghodousi- Zaghi, DDS

Case Study: 3-year-old girl with sleep-disturbances, speech delay, open mouth breathing, trouble chewing, oral dysphagia and chronic nasal congestion found to have Grade 4 tongue-tie and Class III malocclusion.

Madelyn - 3 year-old girl with sleep-disordered breathing, swallow, and speech issues treated with myofunctional therapy and minor surgical procedure (tongue-tie and lip-tie release).

Pre-Op

Noisy mouth breathing with lips apart



Post - Op

Quiet, lips together, nasal breathing

Hindawi
Case Reports in Otolaryngology
Volume 2019, Article ID 3408053, 5 pages
https://doi.org/10.1155/2019/3408053

Case Report

Lingual and Maxillary Labial Frenuloplasty with Myofunctional Therapy as a Treatment for Mouth Breathing and Snoring

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Academic Editor: Rong-San Jiang

Chronic mouth breathing may adversely affect craniofacial development in children and may result in anatomical changes that directly impact the stability and collapsibility of the upper airway during sleep. Mouth breathing is a multifactorial problem that can be attributed to structural, functional, and neurological etiologies, which are not all mutually exclusive. While therapeutic interventions (myofunctional, speech and swallowing, occupational, and craniosacral therapy) may address the functional and behavioral factors that contribute to mouth breathing, progress may sometimes be limited by restrictive lingual and labial frenum that interfere with tongue and lip mobility. This case report explores the case of a three-year-old girl with mouth breathing, snoring, noisy breathing, and oral phase dysphagia that was successfully treated with lingual and labial frenuloplasty as an adjunct to myofunctional therapy. Within four days of the procedure, the patient had stopped snoring and demonstrated complete resolution of open mouth breathing. The patient was also observed to have increased compliance with myofunctional therapy exercises. This report highlights the effectiveness of surgical interventions to improve the efficacy of myofunctional therapy in addressing open mouth posture and low tongue resting position.

Lingual frenuloplasty with myofunctional therapy: Experience with 348 cases exploring saftey and efficacy of tongue-tie release for mouth breathing, snoring, dental clenching, and myofascial tension. [Accepted, In Press - Zaghi et al. 2019, Investigative Otolaryngology]

Table 1. Patient-reported satisfaction with lingual frenuloplasty and myofunctional therapy treatment protocol.

Satisfaction:	Number	Percent Total	
A (very satisfied)	250	71.8%	**Overall Satisfied: 91.1%**
B (somewhat satisfied)	67	19.3%	
C (neutral)	21	6.0%	
D (somewhat dissatisfied)	10	2.9%	**Overall Dissatisfied: 2.9%**
F (very dissatisfied)	0	0.0%	

Table 2. Health-related quality of life following lingual frenuloplasty and myofunctional therapy treatment protocol.

Health-Related Quality of Life:			
A (much better)	137	39.3%	**Overall QOL Improved: 87.4%**
B (somewhat better)	167	48.0%	
C (neutral)	42	12.1%	
D (somewhat worse)	2	0.6%	**Overall QOL Worse: 0.6%**
F (much worse)	0	0.0%	

Table 3. Benefits attributed to lingual frenuloplasty with myofunctional therapy protocol.

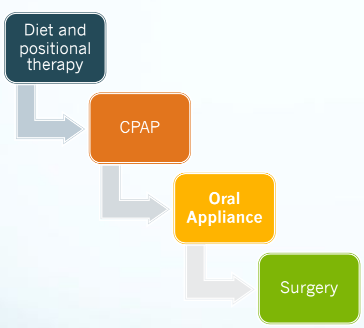
Benefits	Improved	Did Not Improve	Unsure	N/A	Percent Improved	Standard Error
Overall tongue mobility	326	12	10	-	**96.5%**	1.0%
Clenching or grinding of teeth	40	4	-	304	**91.0%**	4.3%
Ability to perform myofunctional therapy exercises	307	35	6	-	**89.8%**	1.6%
Ease of swallow	102	25	3	218	**80.3%**	3.5%
Sleep quality	195	50	11	92	**79.6%**	2.6%
Nasal breathing	174	48	4	122	**78.4%**	2.8%
Neck, shoulder, facial tension or pain	117	34	-	197	**77.5%**	3.4%
Snoring	102	38	11	197	**72.9%**	3.8%

Table 4. Patient reported risks and complications.

Risks/ Complications	Reported	Not Reported	Percent Reported	Standard Error
Pain	157	191	**45.1%**	2.7%
--- Pain for longer than 7 days	5	343	**1.4%**	0.6%
Bleeding	44	304	**12.6%**	1.8%
--- Prolonged bleeding >24 hours	7	341	**2.0%**	0.8%
Numbness of the tongue-tip	17	331	**4.9%**	1.2%
--- Numbness >2 weeks	9	339	**2.6%**	0.9%
Salivary gland issues	12	336	**3.4%**	1.0%
--- Complaints> 2 weeks	3	345	**0.9%**	0.5%
Second stage release procedure to further improve tongue mobility after initial improvement	12	336	**3.4%**	1.0%
Revision surgery to excise scarring that resulted in worse mobility than prior to initial release	11	337	**3.2%**	0.9%

High rates of patient satisfaction and treatment success.
Low risk of minor complications.

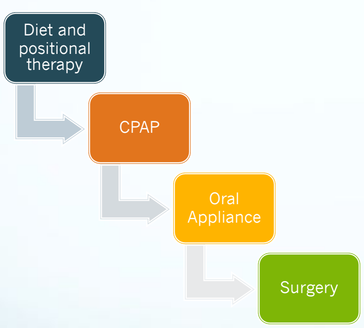
Guidelines Approach: "Step by Step"



Step Three

- Oral Appliance Therapy

Guidelines Approach: Surgery



LJ Epstein, D Kristo, PJ Strollo et al

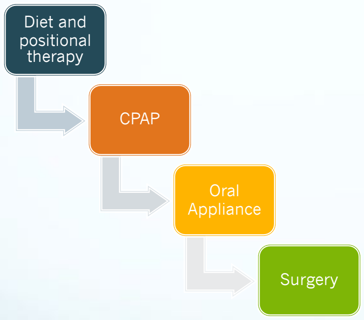
Table 7—Common Surgical Procedures for OSA by Site

Upper Airway Bypass Procedure	**Tracheotomy**
Nasal Procedures	Septoplasty Functional rhinoplasty Nasal valve surgery Turbinate reduction Nasal polypectomy Endoscopic procedures
Oral, Oropharyngeal, and Nasopharyngeal Procedures	Uvulopalatopharyngoplasty and variations Palatal advancement pharyngoplasty Tonsillectomy and/or adenoidectomy Excision of tori mandibularis Palatal implants
Hypopharyngeal Procedures	Tongue Reduction Partial glossectomy Tongue ablation Lingual tonsillectomy Tongue Advancement/Stabilization Genioglossus advancement Hyoid suspension Mandibular advancement Tongue suspension
Laryngeal Procedures	Epiglottoplasty Hyoid suspension
Global Airway Procedures	Maxillomandibular advancement Bariatric surgery

Step Four

- Surgical Options

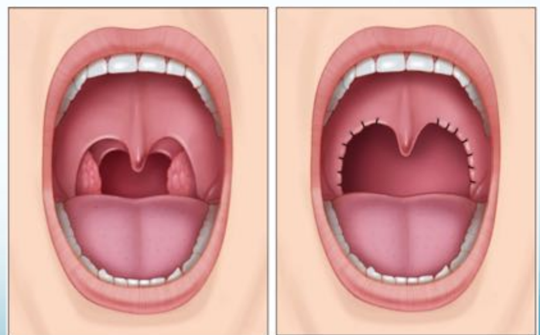
Surgical Options- Phase 1



Step Four- Phase 1 Surgery

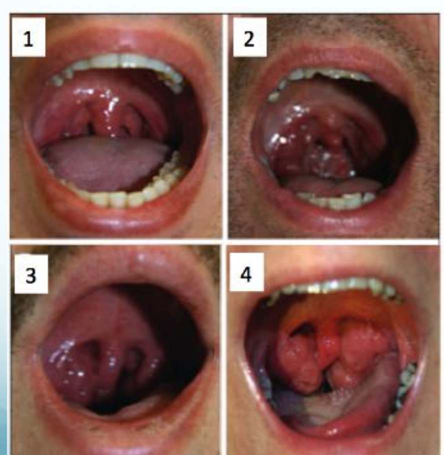
- Tonsils/ Throat Surgery

UPPP: Uvulopalatopharyngoplasty



To Evaluate Candidates for UPPP Surgery

Tonsil Size



Friedman ***Tongue Position*** Classification

Clinical staging for sleep-disordered breathing

Friedman M, Ibrahim H, Bass L. Otolaryngology-Head Neck Surg. 2002 Jul;127(1):13-21.

Table 1. Staging system

	Friedman palate position	Tonsil size	Body mass index (kg/m^2)
Stage I	1	3, 4	<40
	2	3, 4	<40
Stage II	1, 2	0, 1, 2	<40
	3, 4	3, 4	<40
Stage III	3	0, 1, 2	Any
	4	0, 1, 2	Any
	Any	Any	>40

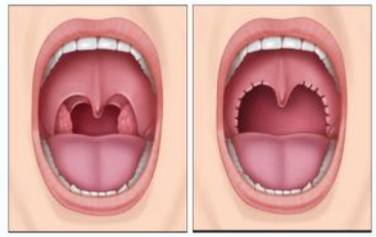


Table 4. Success rate of uvulopalatopharyngoplasty in the treatment of sleep-disordered breathing

Stage	Unsuccessful	Successful	Total
I	6 (19.4)	25 (80.6)*	31 (100)
II	18 (62.1)	11 (37.9)*	29 (100)
III	68 (91.9)	6 (8.1)*	74 (100)

Patients were stratified according to severity of disease based on criteria from Friedman et al. (1999). Values given as number (percent).
*Significant differences than all other stages.

Friedman Stage I: 80.6 % rate of surgical success with UPPP

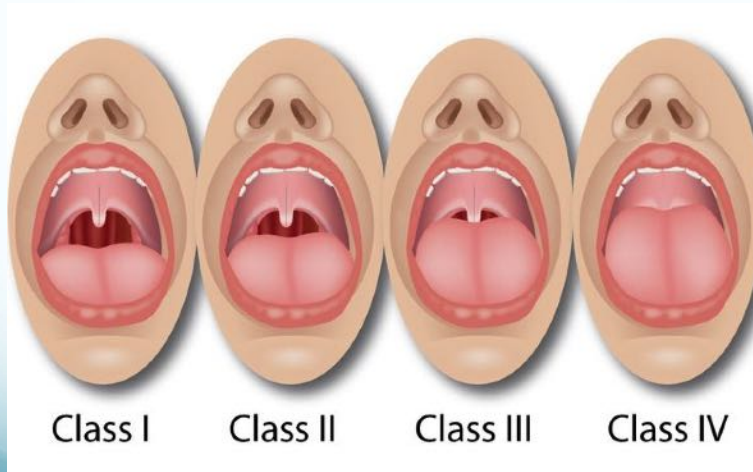
Friedman Stage II: 37.9 % rate of surgical success with UPPP

Friedman Stage III: 8.1 % rate of surgical success with UPPP

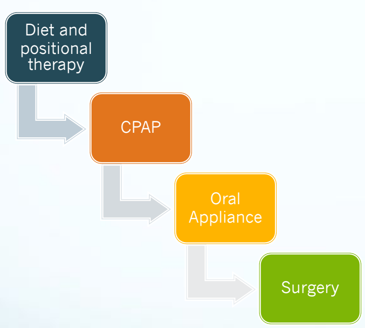
Tongue Position: Mallampati Classification

Modified with No Tongue Protrusion

Class I: Entire uvula and tonsil pillars visible
Class II: Soft palate and most of the uvula visible.
Class III: Soft palate +/- base of uvula visible.
Class IV: Only hard palate visible.



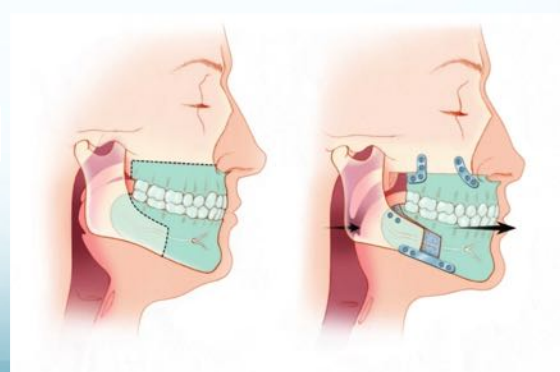
Guidelines Approach: "Step by Step"

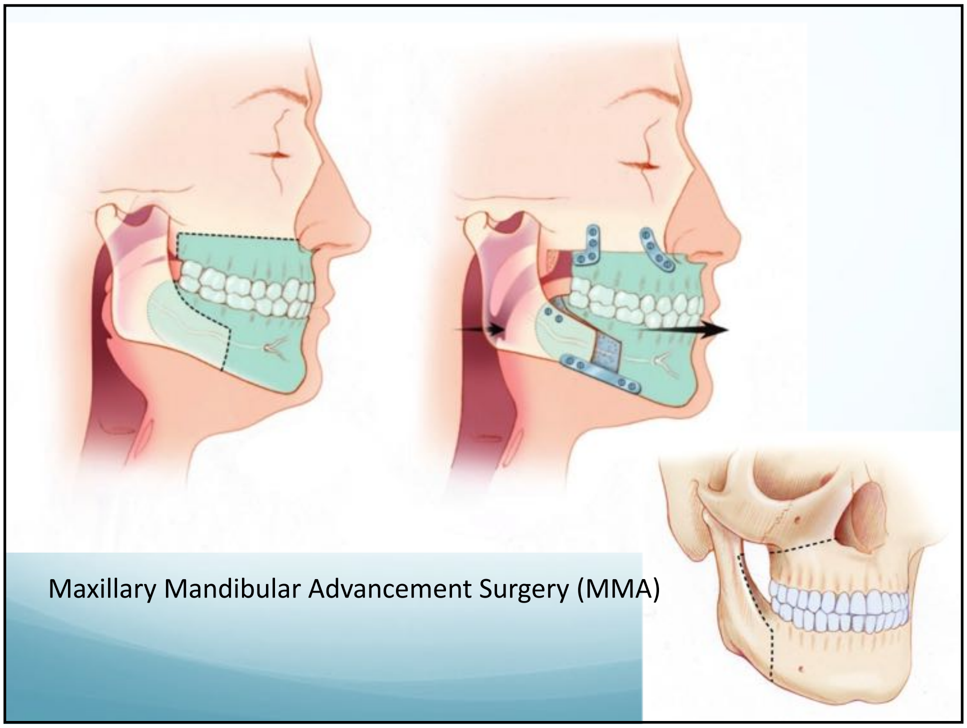


Step Five- Phase 2 Surgery

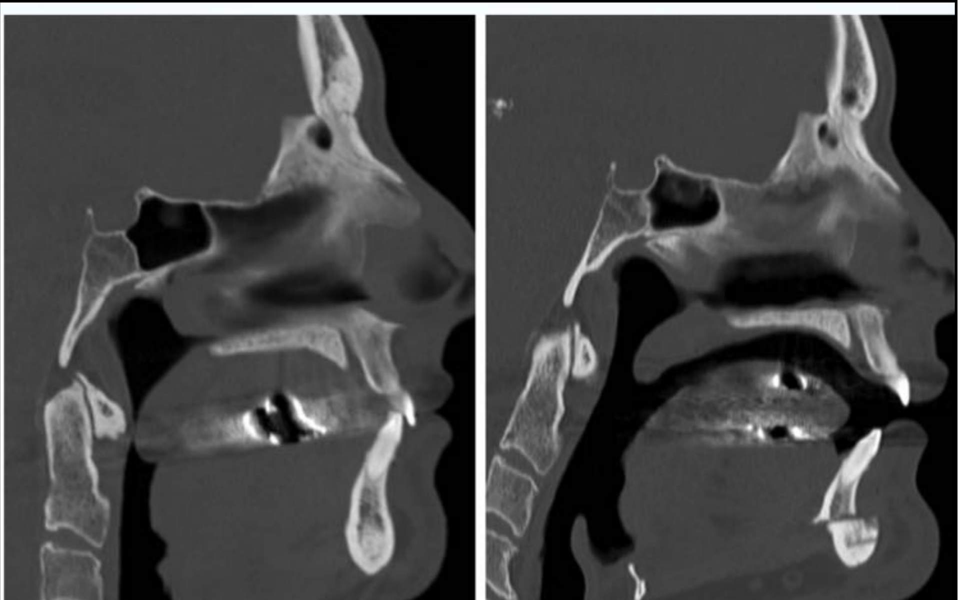
- Maxillofacial / Tongue-Base

MMA: Maxillary Mandibular Advancement
HGNS: Inspire Hypoglossal Nerve Stimulator





Maxillary Mandibular Advancement Surgery (MMA)



Maxillomandibular Advancement for Treatment of Obstructive Sleep Apnea: A Meta-analysis
S Zaghi, JEC Holty, V Certal, J Abdullatif, C Guilleminault, NB Powell, ...
JAMA Otolaryngology–Head & Neck Surgery, 1-9

Cone Beam Computed Tomography: Craniofacial and Airway Analysis

David C. Hatcher, DDS, MSc[a,b,c,*]

Assessment of Cross-Sectional Airway Space

High probability of OSA less than 52 mm.^{2}

Moderate probability of OSA greater than 52 mm.^{2} but less than 110mm^2

Low probability of OSA greater than 110mm^2

This article originally appeared in *Sleep Medicine Clinics, Volume 5, Number 1, 2010.*
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[c] Private Practice, Diagnostic Digital Imaging, 99 Scripps Drive, #101, Sacramento, CA 95825, USA
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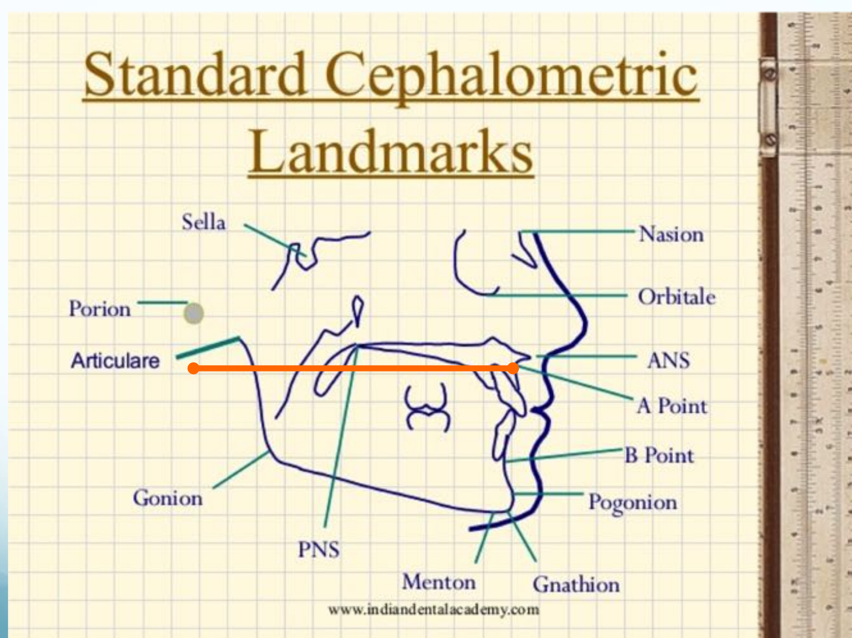
Dent Clin N Am 56 (2012) 343–357
doi:10.1016/j.cden.2012.02.002 dental.theclinics.com

Slide Credit: Dr. Bill Hang



Anatomic Determinants of Sleep-Disordered Breathing Across the Spectrum of Clinical and Nonclinical Male Subjects*

Jerome A. Dempsey, PhD; James B. Skatrud, MD; Anthony J. Jacques, BS; Stanley J. Ewanowski, PhD; B. Tucker Woodson, MD; Pamela R. Hanson, DDS, MS; and Brian Goodman, PhD

FIGURE 2. Cephalometric dimensions that made significant contributions to the variance in AHI. Dimension PV-A (parallel to FH) was the single airway dimension that contributed most significantly to variations in AHI within the study population. Go-SE-PNS = gonion-SE-PNS; Co-Po = condylion-pogonion; Go-Gn = gonion-gnathion. See Table 1 for expansion of other abbreviations.

Table 5—*Comparison Between Group Mean Values for PV-A Distance ≤ 97 mm vs PV-A Distance > 97 mm in the AHI Multiple Regression Models**

Cephalometric Measures	One-Way ANOVA PV-A ≤ 97 mm	One-Way ANOVA PV-A > 97 mm	p Value
Patients, No.	51	120	
AHI	40.19	20.31	0.000
SD	33.89	20.53	
BMI	31.09	29.43	0.031
SD	6.32	4.64	
Age	47.04	46.05	0.4
SD	8.73	7.83	
PV-A	88.96	104.65	0.000
SD	5.06	5.47	
H-PV	29.44	44.98	0.000
SD	8.47	10.91	
H-SO	93.75	102.56	0.000
SD	8.58	8.27	
PAS_1	10.47	10.19	0.611
SD	3.91	3.73	
(MnAR-MnAI)-(N-B)	35.17	37.30	0.710
SD	36.32	40.42	

*(MnAR-MnAI)-(N-B) = the mandibular incisor angle; H-PV = hyoid to porion vertical parallel to FH; H-SO = hyoid to the SO parallel to porion vertical.

Assessment of Posterior Airway Space: Retromaxillary, Retropalatal, Retrolingual

32 year-old normal female without restricted posterior airway space

56 year-old male with severe obstructive sleep apnea

Notice altered head posture

25 year-old male with compensated neck posture due to restricted airway

This dynamic MRI demonstrates how various neck postures can affect the airway.

Head Tilt / Chin Lift to Open Airway → Compressed Neck Posture

36 years old female with neck tension and forward head posture.

Natural
Head Position

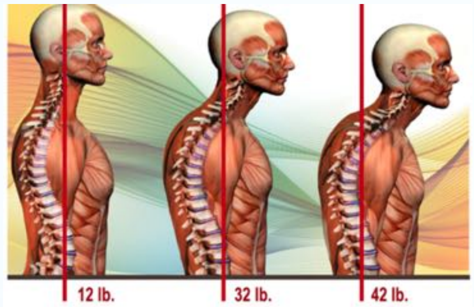
Most habitual position with eyes focused on a point in the distance at eye level (horizontal visual axis).

"Neutral"
Head Position

Ears aligned over the shoulders in side profile.

“Compensating” Head Position

Head Tilt / Chin Lift



The average human head weighs 8 - 12lbs.

Cervical spine has a natural 43 degree arc that acts like suspension for your head. As you move around, whether walking or sitting down, the curve in your neck compresses like a spring to take the pressure of your head off your body.

Forward head posture reduces the arc of of suspension in your neck and it moves the weight of the head forward away from your center of gravity.

Credit: https://www.thechirocentre.co.uk/blog/chiropractic/weight-world-on-your-shoulders

36 year old male with a history of jaw pain and neck, shoulder, and back tension.

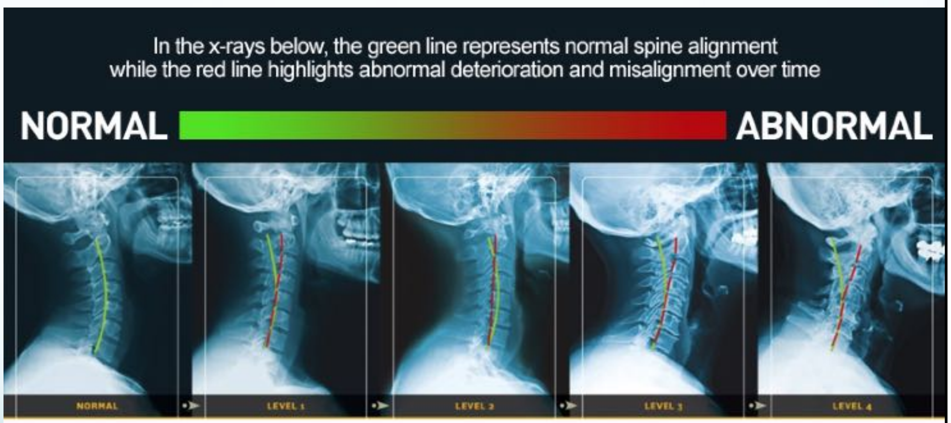


Figure 1. Image

What's so bad about loosing the curve in your neck?

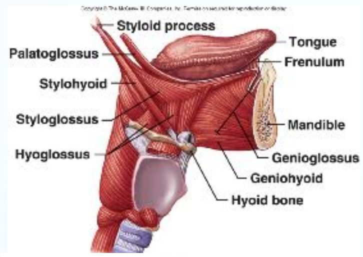
Well, we read earlier that it can cause symptoms like neck pain and headaches, even sometimes tingling into the hands. In a study that studied 6000 people with chronic headaches, the only common finding they found was a loss or reversal of the normal curve in the neck! However, research also tells us that it can speed up and cause premature onset of osteoarthritis (wear and tear) of the joints and degeneration of the discs (shock absorbers) of the cervical (neck) spine. It also tells us that it can decrease your lung breathing capacity by 30% among other effects! So as you can see it is very important to maintain the proper alignment of the joints in your neck

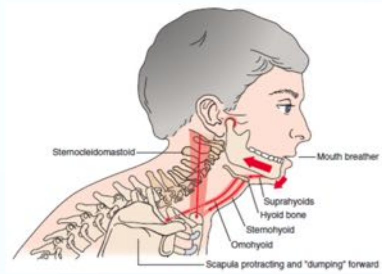
Credit: https://www.thechirocentre.co.uk/blog/chiropractic/weight-world-on-your-shoulders

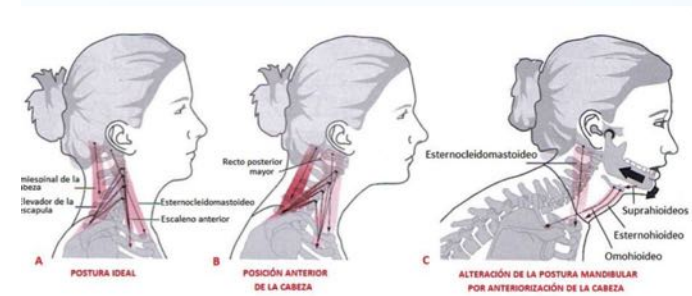
13 year-old girl with difficulty breastfeeding, speech impediment, swallow difficulties, tongue thrust, maxillofacial underdevelopment, dental crowding, forward head posture

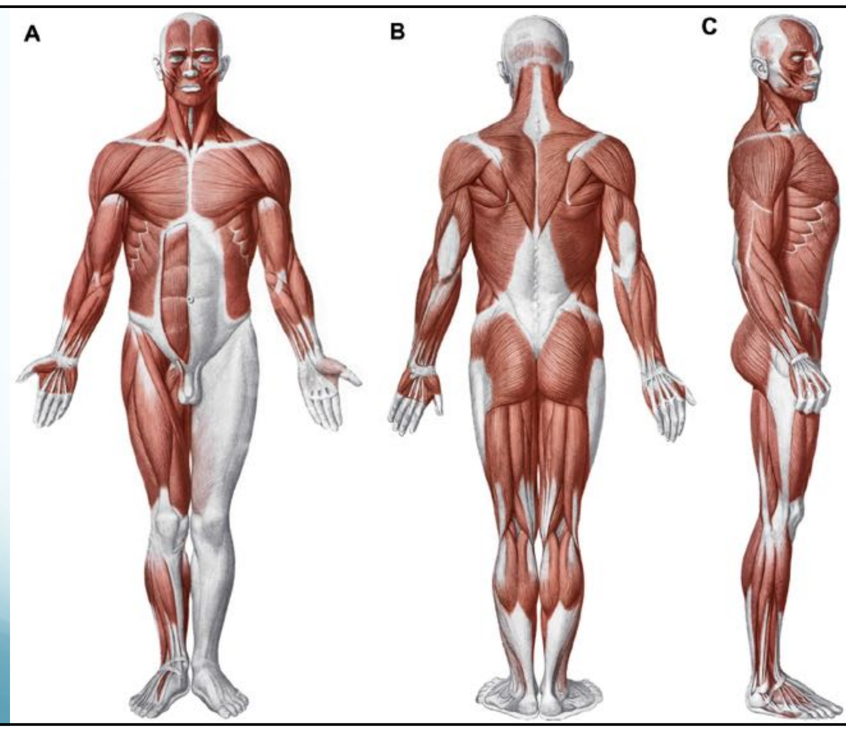
Restricted tongue mobility

Posture and Fascia System

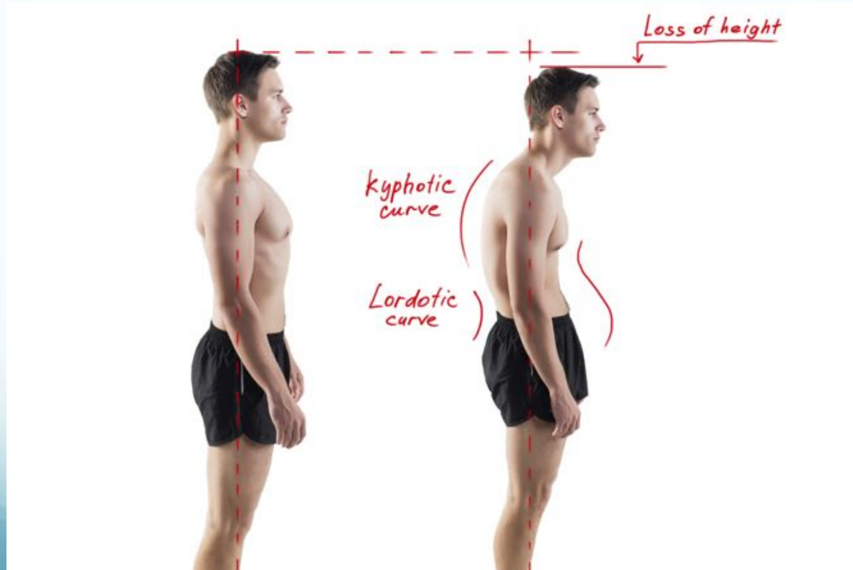


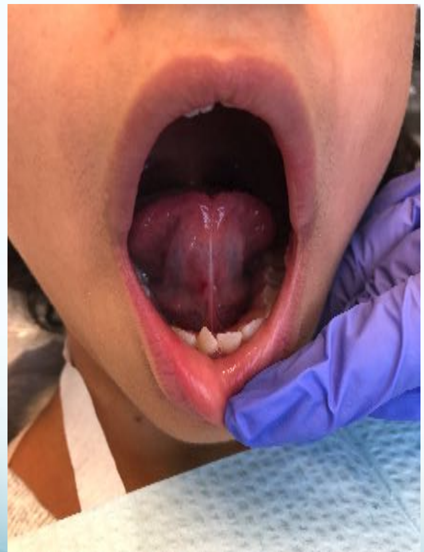


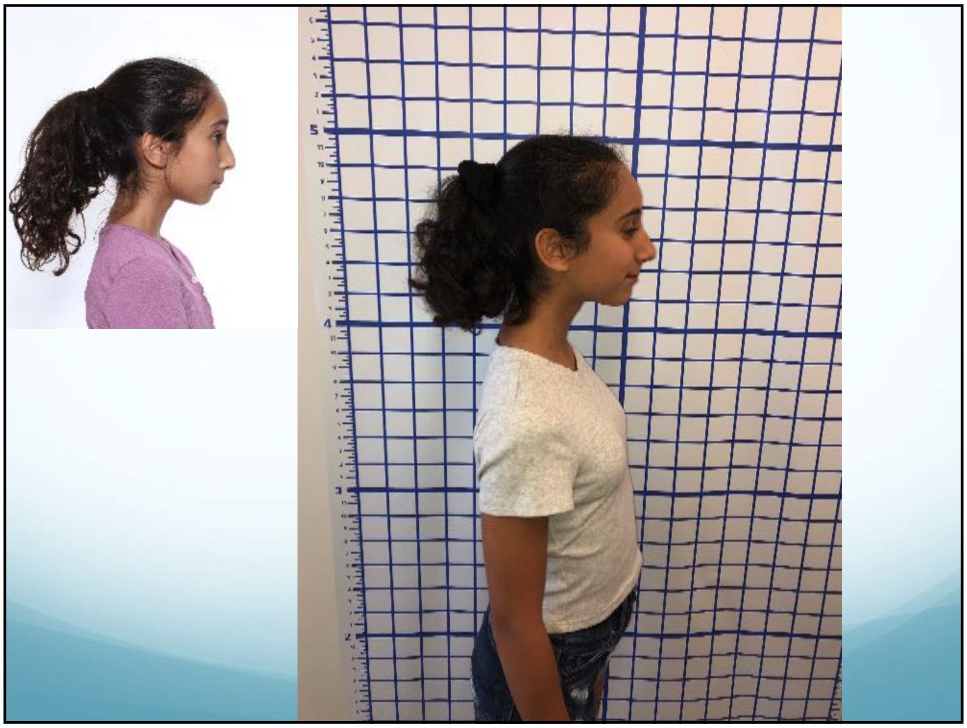


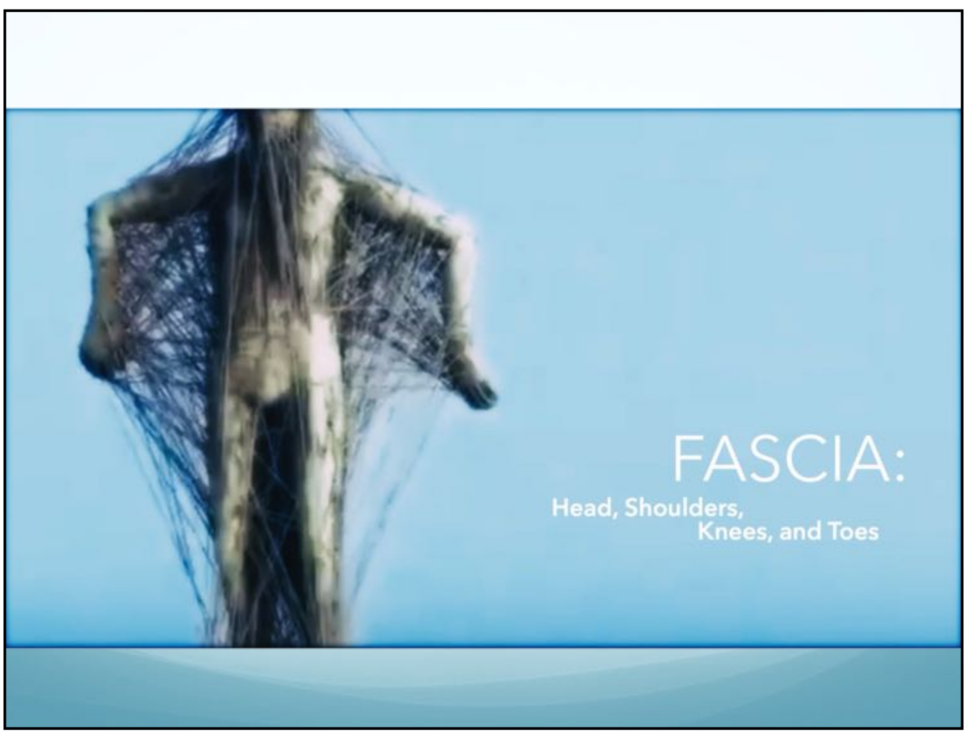


Effects of Restricted Fascia System








FASCIA:
Head, Shoulders,
Knees, and Toes

Lingual frenuloplasty with myofunctional therapy: Experience with 348 cases exploring saftey and efficacy of tongue-tie release for mouth breathing, snoring, dental clenching, and myofascial tension. [Accepted, In Press - Zaghi et al. 2019, Investigative Otolaryngology]

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Snoring	102	38	11	197	**72.9%**	3.8%

32 year-old normal female without restricted posterior airway space

Notice high resting tongue position, good airway, no spinal compensations

32 year-old male with snoring, low tongue posture, and adequate posterior airway space

Good candidate for myofunctional therapy +/- tongue-tie surgery.

68 year-old female with low tongue position, restricted airway, and spinal compensations

Is she a good candidate for tongue-tie surgery? No!

Dr. Homer Simpson's Spino-Cylinder*

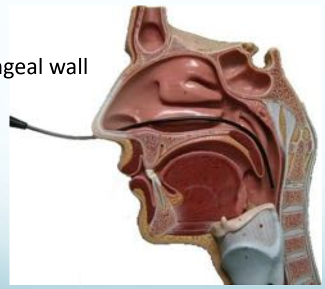
** Patent Pending*

Precision Diagnosis: SLEEP ENDOSCOPY

SUCCESSFUL TREATMENT OF SNORING & SLEEP APNEA is based on the accurate identification of the pattern of airway obstruction.

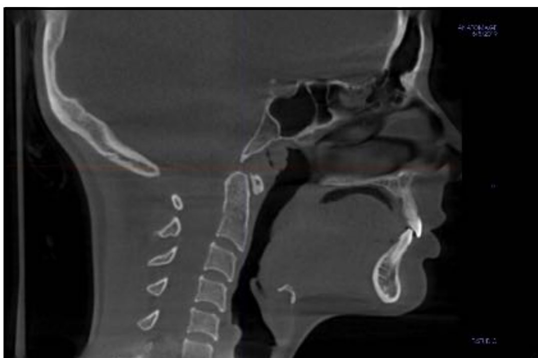
In the throat, there are four major areas that can be responsible:

- Palate
- Lateral pharyngeal wall
- Tongue
- Epiglottis



Precise diagnosis allows for targeted and effective treatment.

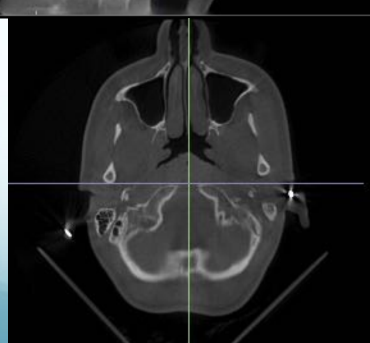
- ✧ Assessing severity of airway collapsiblity
- ✧ Identifying pattern and sites of obstruction
- ✧ Demonstrating factors that interfere with use of CPAP
- ✧ Predicting response to oral appliance, CPAP, or surgery

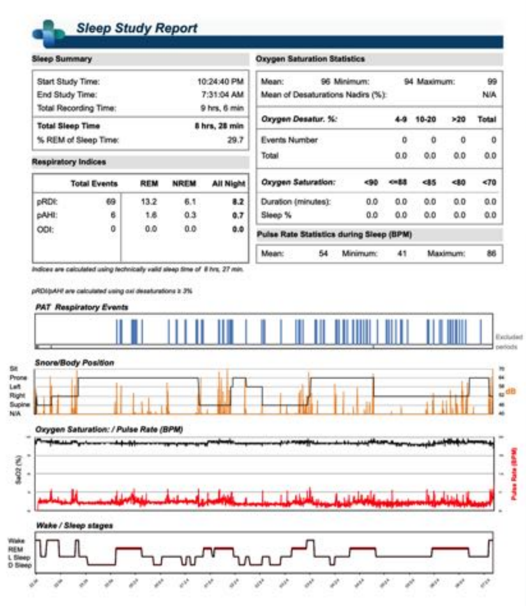


27 y/o female with fatigue and insomnia

RDI 8.2 events/hr
AHI 0.7 events/hr
ODI 0.0 events/hr

Cross-Sectional Area: 248 mm^2
Posterior Airway Space: 7.8 – 11 mm
PVA Line: 85 mm



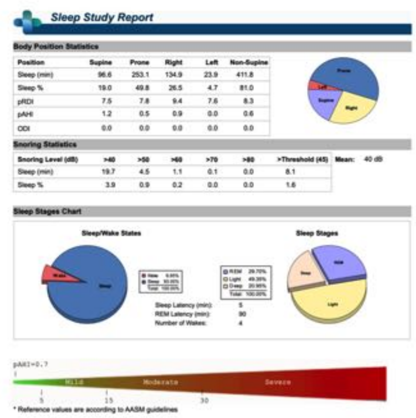


	Total Events	REM	NREM	All Night
pRDI:	69	13.2	6.1	8.2
pAHI:	6	1.6	0.3	0.7
ODI:	0	0.0	0.0	0.0

Oxygen Desatur. %:	4-9	10-20	>20	Total
Events Number	0	0	0	0
Total	0.0	0.0	0.0	0.0

Oxygen Saturation:	<90	<=88	<85	<80	<70
Duration (minutes):	0.0	0.0	0.0	0.0	0.0
Sleep %	0.0	0.0	0.0	0.0	0.0

Sleep Study: "Normal"



Position	Supine	Prone	Right	Left	Non-Supine
Sleep (min)	96.6	253.1	134.9	23.9	411.8
Sleep %	19.0	49.8	26.5	4.7	81.0
pRDI	7.5	7.8	9.4	7.6	8.3
pAHI	1.2	0.5	0.9	0.0	0.6
ODI	0.0	0.0	0.0	0.0	0.0

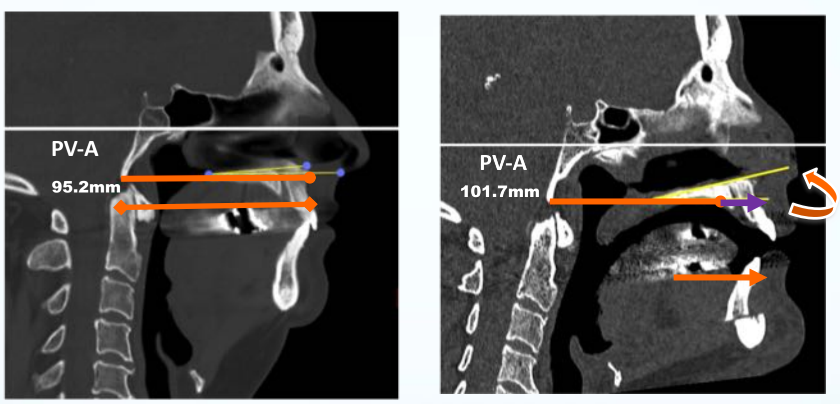
Snoring Level (dB)	>40	>50	>60	>70	>80	>Threshold (45)
Sleep (min)	19.7	4.5	1.1	0.1	0.0	8.1
Sleep %	3.9	0.9	0.2	0.0	0.0	1.6

"I feel like I was awake the whole night"

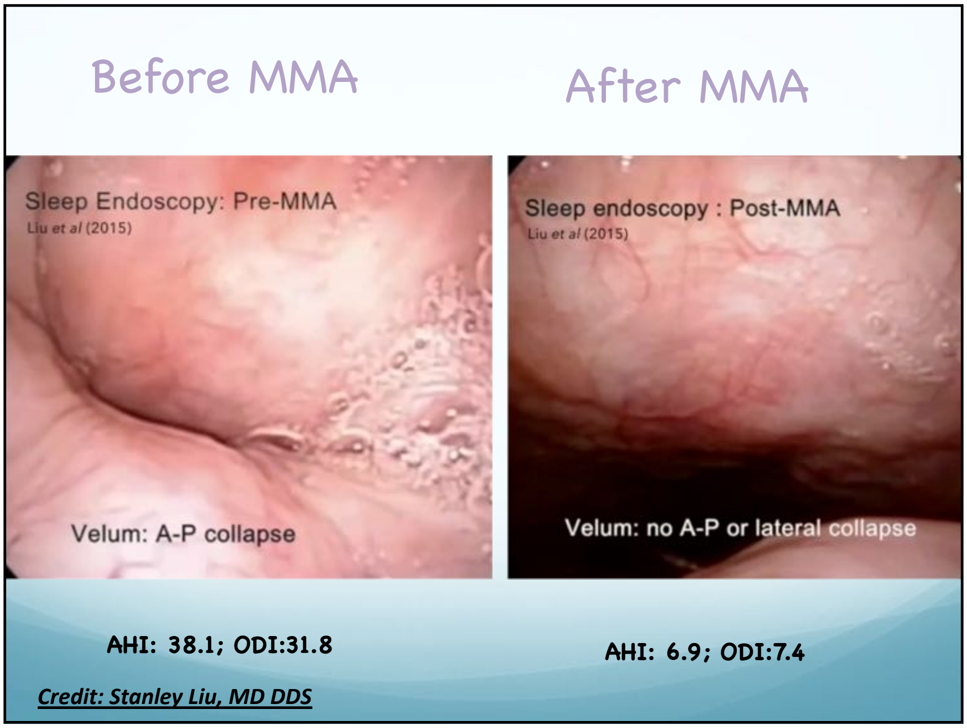
Diagnosis involves interpreting the history, **clinical observations, imaging studies, and test results** to estimate the presence and/or severity of the syndrome: unlikely, possible, probable, definite; mild, moderate, severe.

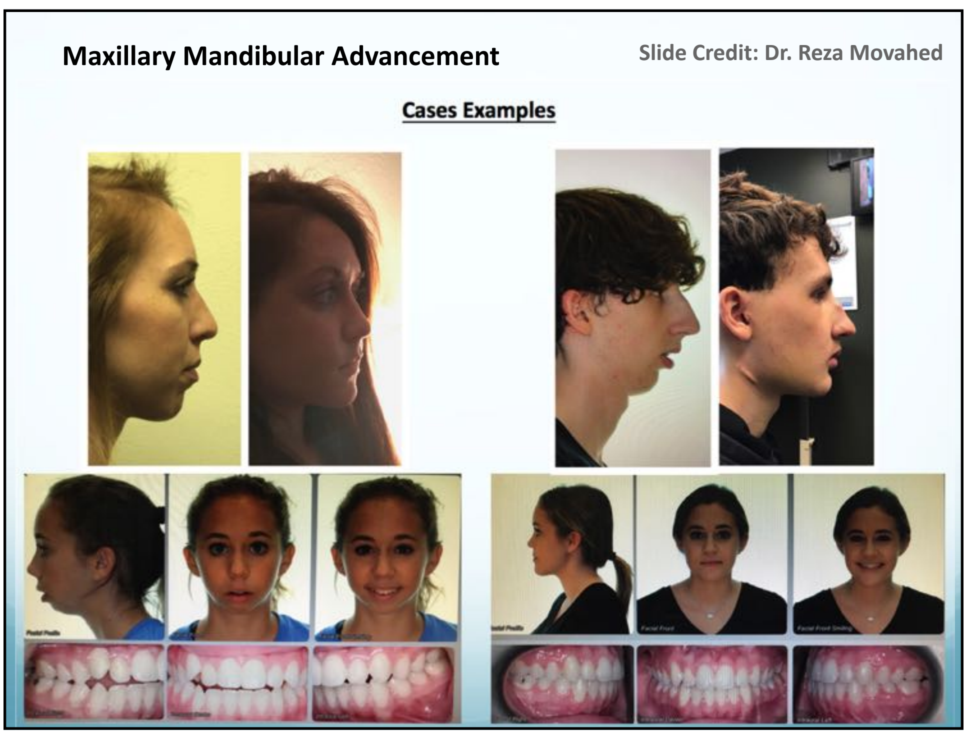
54 year old male before and after MMA

Credit: Stanley Liu, MD DDS



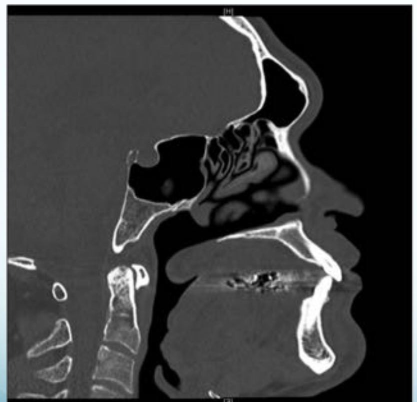
Case: 54 year-old male, History of UPPP	
Maxilla Advancement	6.5mm
CCW rotation	12.05 degree
AHI	*38.1 → 6.9 events/hour*


Before MMA
After MMA
Sleep Endoscopy: Pre-MMA
Liu et al (2015)
Velum: A-P collapse
Sleep endoscopy : Post-MMA
Liu et al (2015)
Velum: no A-P or lateral collapse
AHI: 38.1; ODI:31.8
AHI: 6.9; ODI:7.4
Credit: Stanley Liu, MD DDS


Maxillary Mandibular Advancement
Slide Credit: Dr. Reza Movahed
Cases Examples

Functional restriction after maxillary mandibular advancement surgery: Persistent tongue-base obstruction.

Pre-Operative CT Scan (Before MMA Surgery)



Post-Operative CT Scan (2 Days after MMA Surgery)

The tongue is still blocking the airway

Patient with prior MMA now with evidence of tongue base collapse

Credit: Robson Capasso, MD

Hypoglossal nerve stimulation in the treatment of obstructive sleep apnea: A systematic review and meta-analysis
VF Certal, S Zaghi, M Riaz, AS Vieira, CT Pinheiro, C Kushida, ...
The Laryngoscope 125 (5), 1254-1264

Hypoglossal Nerve Stimulator

inspire®
UPPER AIRWAY STIMULATION

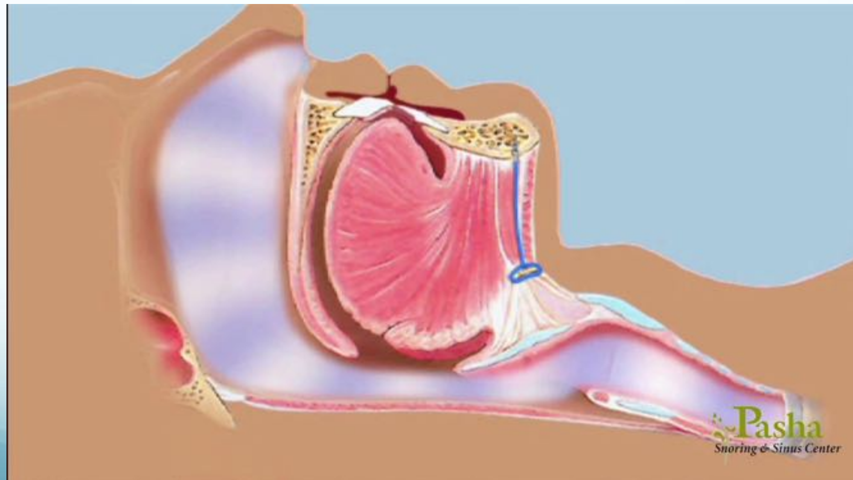
Inspire Therapy Procedure Overview:

Typically an Outpatient Procedure
- General anesthesia

Pain Management
- Mild discomfort and swelling at the incision sites for a few days after the procedure, typically managed with ibuprofen or acetaminophen

Recovery
- Return to regular diet and most activities of daily living immediately after the procedure
- Avoid strenuous activities for a few weeks

Hyoid Suspension

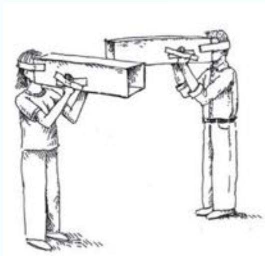


Pre- Hyoid Suspension

Post- Hyoid Suspension

29 year-old male with persistent SDB despite prior Turbinate Reduction, Septoplasty, MMA, Lingual Frenuloplasty, and UPPP

Credit: Dr. Reza Movahed



- "Guideline" Approach:
  - CPAP
  - Behavioral Therapy
  - Oral Appliance
  - Surgery: Tonsillectomy
  - More surgery.

Guideline approach: Aims to manage and reduce effects of sleep disordered breathing.

- Functional Approach:
  - Myofunctional therapy +/- Frenuloplasty
  - Surgery: Tonsillectomy
  - Dental orthopedic remodeling (skeletal maxillary expansion)

Functional approach: Identify and treat the root causes of sleep disordered breathing.

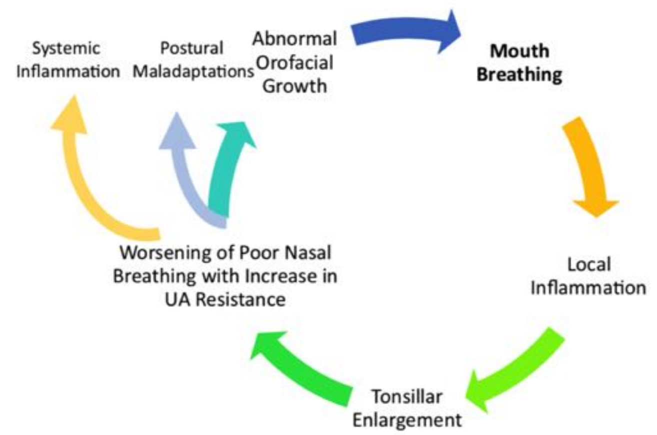


Fig. 13. Mouth-breathing and its negative impacts.
The many negative impacts of mouth breathing are summarized in the Schema with indication of the induced vicious cycles.

Guilleminault C et al., The nocturnal-polysomnogram and "non-hypoxic sleep-disordered-breathing" in children, Sleep Medicine, https://doi.org/10.1016/j.sleep.2018.11.001

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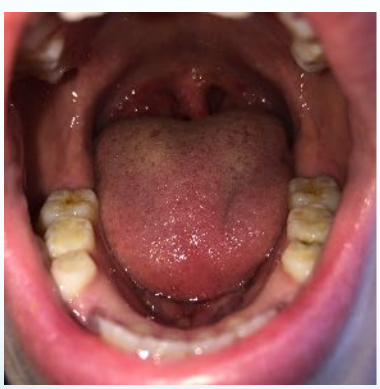
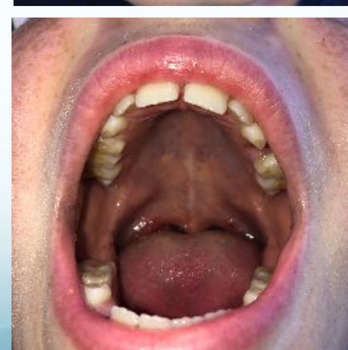
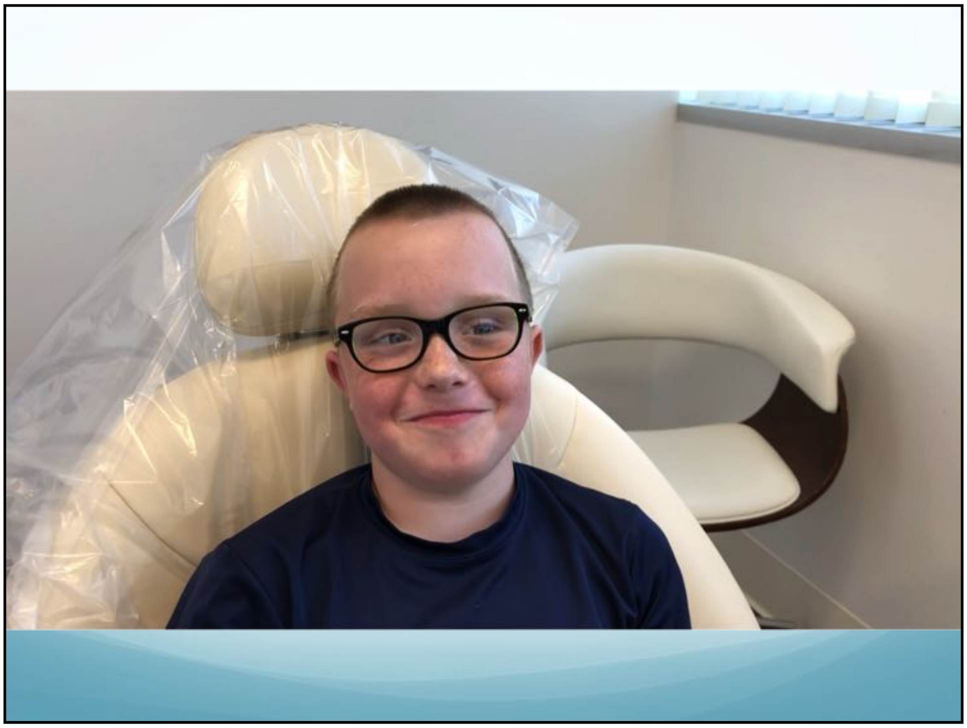
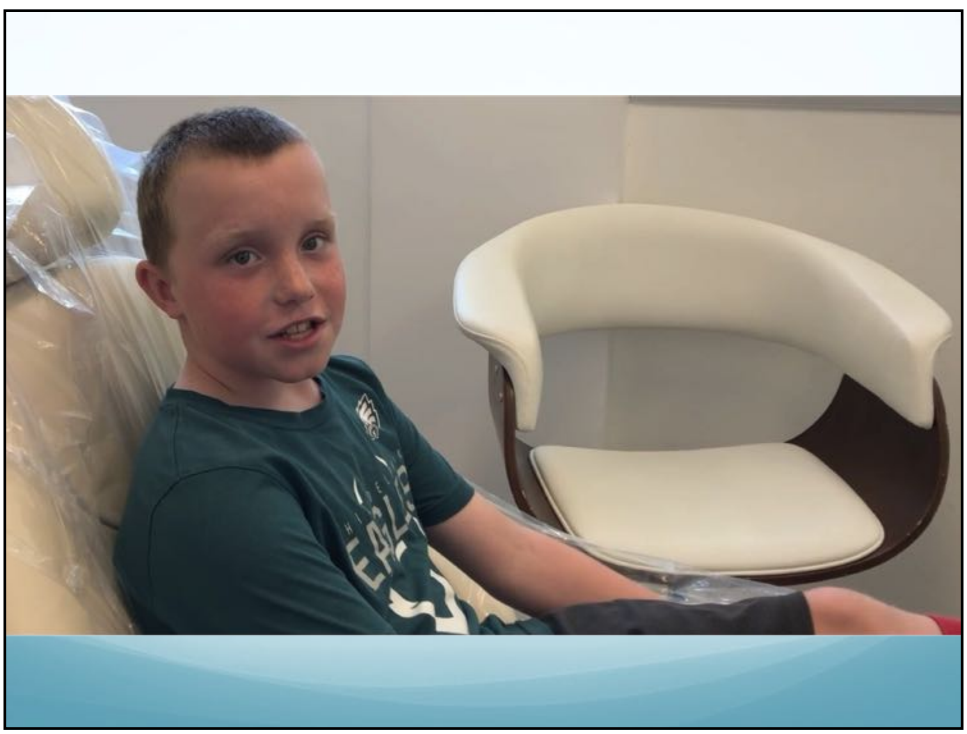
8 year-old boy presenting with dental grinding

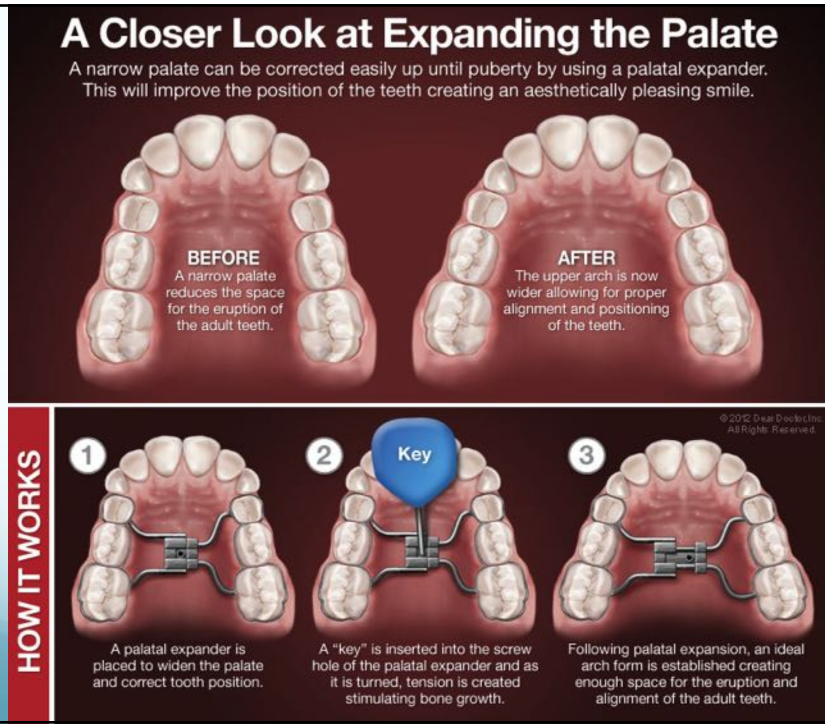




\+ mouth breathing, snoring, sleep, attention issues

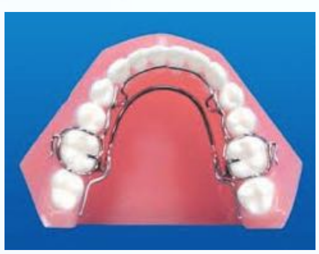






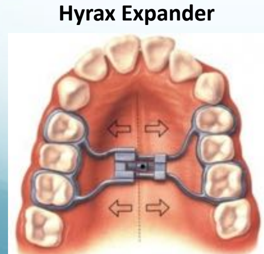
Dental - Skeletal Expansion

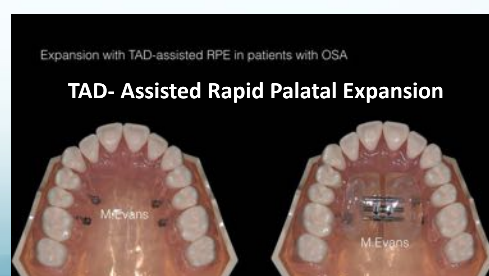
Crozat / ALF / BWS



Maxillary Skeletal Expander

Hyrax Expander





Dental - Skeletal Expansion

DNA Appliance

FAGGA- Fixed Anterior Growth Guidance Appliance

Invisalign / Orthodontic Braces

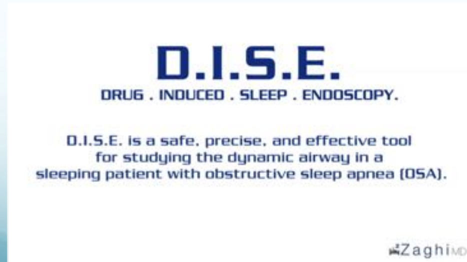
Controlled Arch Orthodontics

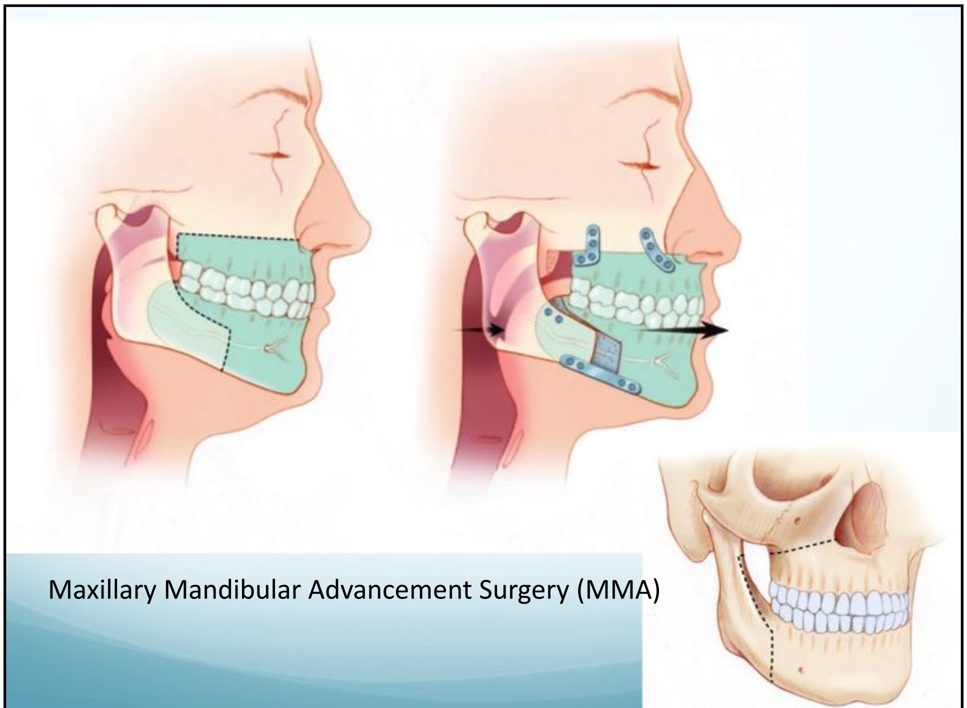
Sleep-Disordered Breathing (SDB)

Austin

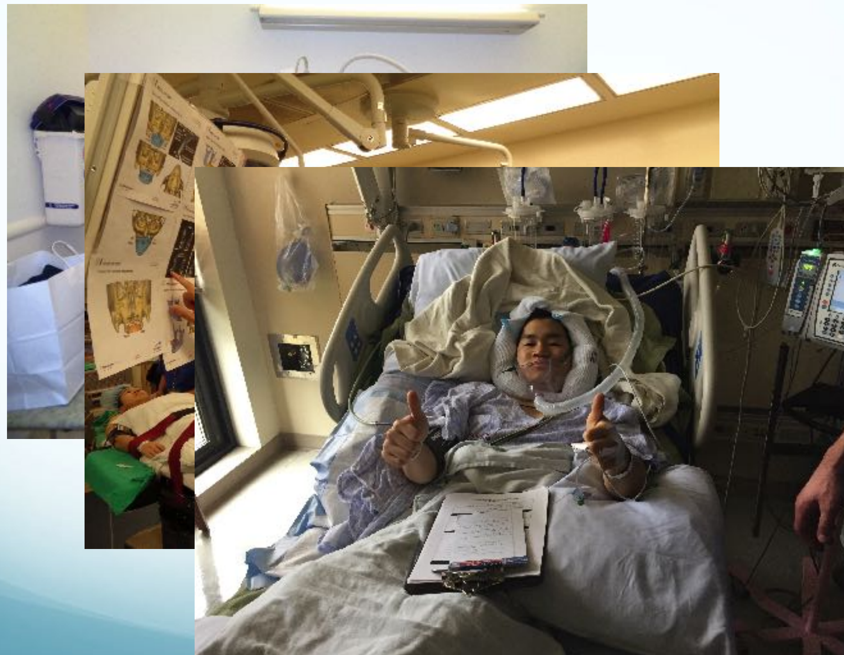
27-year-old male

- "ADHD" attention issues, unrefreshing sleep as a child
- Developed loud snoring and noticeable breathing interruptions around 15-16 years of age.
- Progressive worsening …..

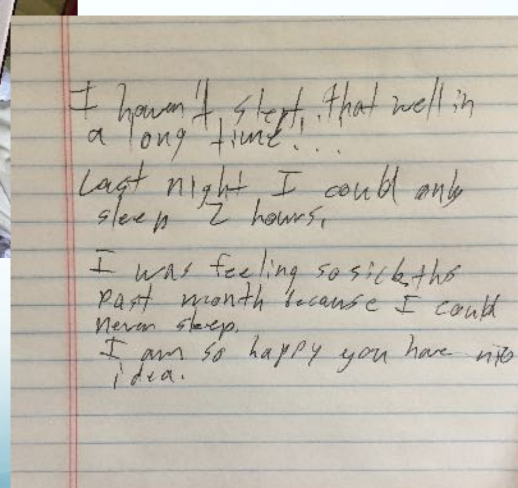




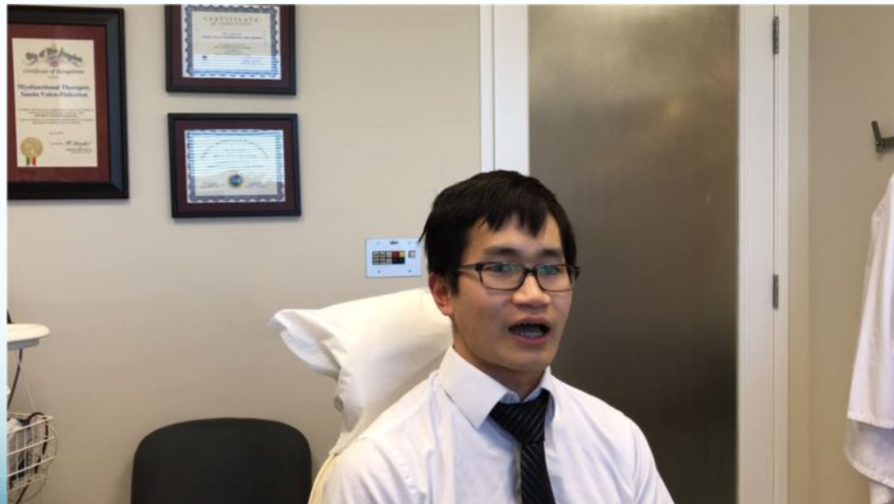
Maxillary Mandibular Advancement Surgery (MMA)



Austin: 1 Day s/p Maxillary Mandibular Advancement Surgery



Austin: 2 Months s/p Maxillary Mandibular Advancement Surgery



Thank you!

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Nasal Breathing, Snoring, and Sleep Apnea
Tongue-Tie and Maxillofacial Development

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