Obesity and Sleep Apnea

Mekhala Chandra, MD, ABOM certified.

Disclosures

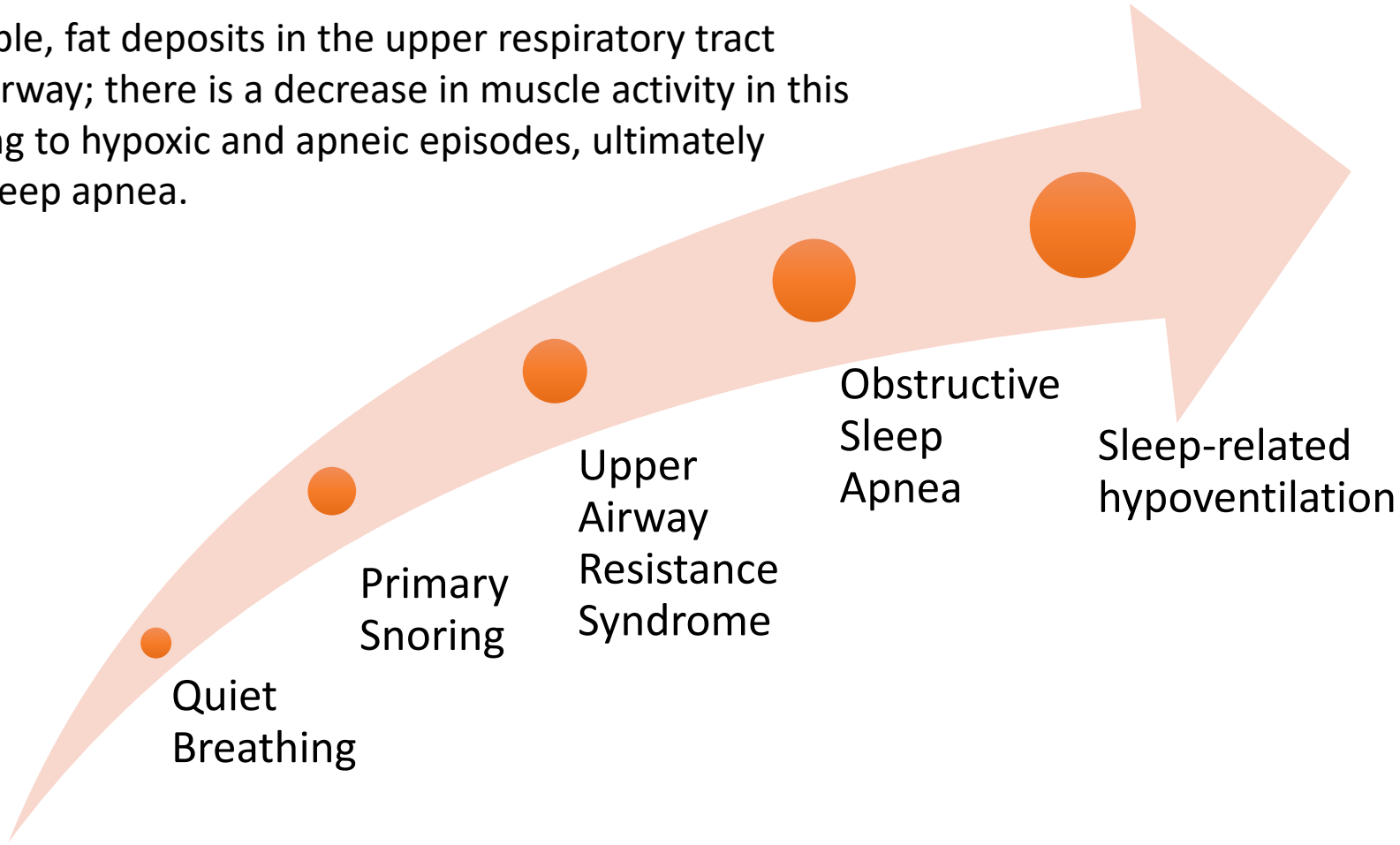
- None

Objectives

- To understand the underlying pathophysiology of OSA
- To understand the relationship between obesity and OSA
- To understand the evaluative process for OSA in Obesity Medicine patients
- To be familiar with treatment options for patient’s with obesity and comorbid OSA

Conceptual Framework

In obese people, fat deposits in the upper respiratory tract narrow the airway; there is a decrease in muscle activity in this region, leading to hypoxic and apneic episodes, ultimately resulting in sleep apnea.



What exactly happens……

- The obstruction in breathing due to the narrowing of the upper airway causes a marked increase in intrathoracic pressure and triggers apnea and hypoxia [*Destors M;Presse Med. 2017 Apr; 46(4):395-403*].

- There is an increased sympathetic activation due to apnea/hypoxia episodes in OSAS patients [P*hillips BG;Am J Physiol Heart Circ Physiol. 2000 Jul; 279(1):H234-7*].

- Episodes of hypoxemia/apnea can drop the oxyhemoglobin saturation from 95% to 80%, depending on the length of the period of apnea.

OSA causes hypoxic injury

- These hypoxia/apnea episodes lead to a decrease in oxygen that is available in body tissues and blood vessels. The decreased oxygenation causes tissue hypoxia, which is the main contributing factor to atherosclerosis, the main risk factor for Cardiovascular Diseases (CVD) [Chen X, Obstructive sleep apnea and multiple anthropometric indices of general obesity and abdominal obesity among young adults. *Int J Soc Sci Stud.* 2014;2(3):89–99]

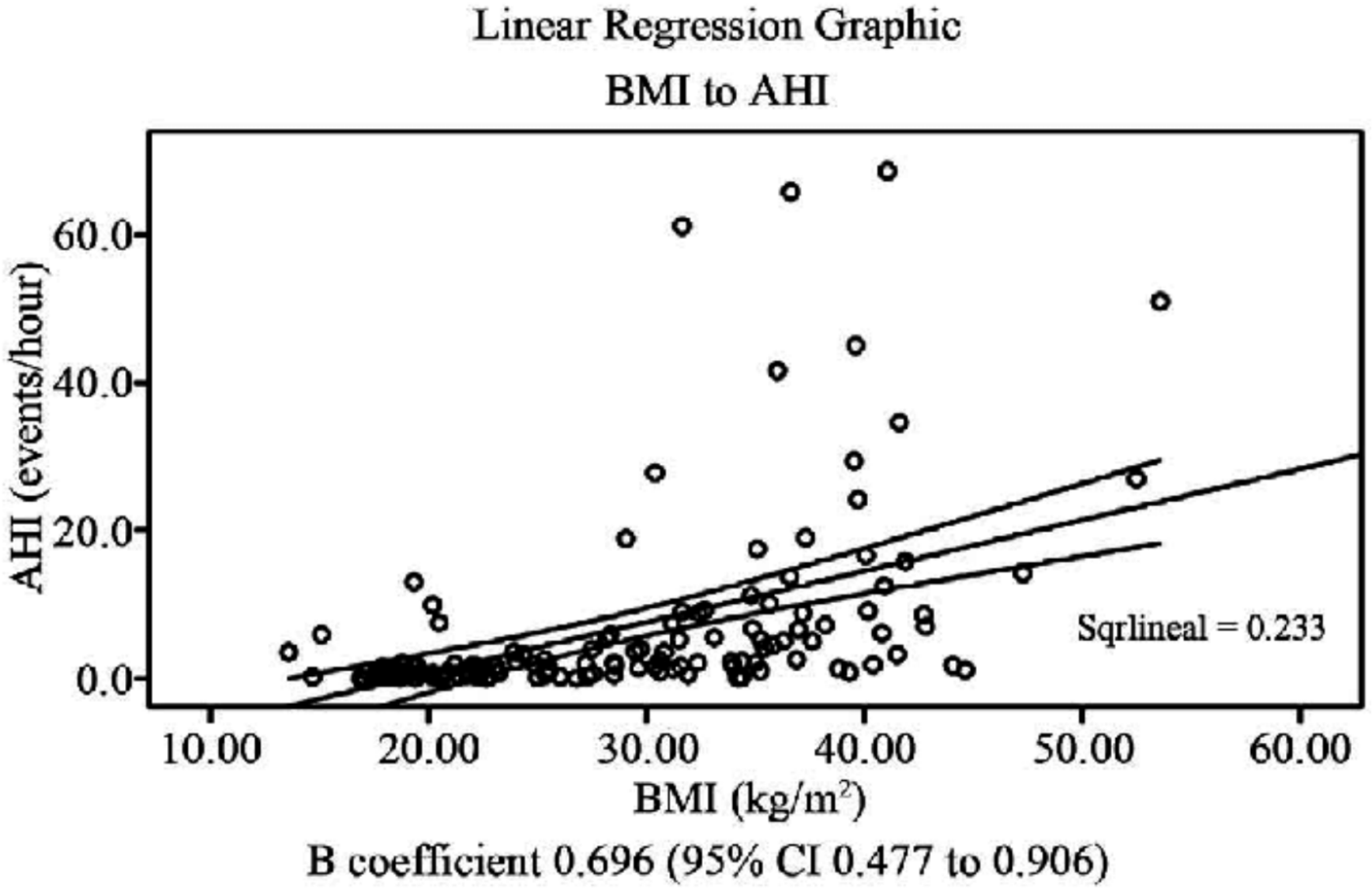
Hypoxia Drives CV Risk

- OSA is an independent risk factor for cardiovascular and cerebrovascular diseases.
- Due to the hypoxia-related to OSAS, the oxidative stress leads to overproduction of reactive oxygen species, which can cause endothelial dysfunction and result in atherosclerosis.
- The inflammatory marker C-reactive protein (CRP), tumor necrosis factor α (TNF α), and interleukin-6 (IL-6) are increased in patients with OSA and significantly elevated when the AHI is 15 or greater [*Jehan S;J Sleep Med Disord. 2016; 3(6)].*

Association Between Obesity and OSA

- A four-year longitudinal study of overweight and obese American adults demonstrated that change in weight is directly proportionate to sleep disordered breathing (SDB).

- Those with the greatest weight gain had a more severe apnea-hypopnea index (AHI). [*Peppard PE, Young T, Palta M, Dempsey J, Skatrud J, JAMA. 2000 Dec 20; 284(23):3015-21.]*



Linear relationship between BMI and AHI. increased risk for all three grades of OSAHS (i.e. mild OSAHS = OR 6.20, 95% CI 1.75 -10.65, moderate OSAHS = OR 7.94, 95% CI 3.37 -12.51, and severe OSAHS = OR 8.99, 95% CI 4.34 -13.63; L.R. X2 = 49.96; p ? 0.001). The rest of the covariates are shown in Table 3.

OSA in Metabolic Syndrome

- The risk of OSA increases with age and body mass index (BMI); other associated factors seen in a cohort of Australian men includes sedentary lifestyle, tobacco abuse, and heavy alcohol use.

- OSA is strongly correlated with multiple disease conditions, including type 2 diabetes mellitus (T2DM), hyperlipidemia, hypertension, heart failure, cardiovascular diseases (CVD) and depression.[*BMC Public Health. 2016 Oct 31; 16(Suppl 3):1029.]*

Obesity and Sleep

- People who are obese (with a BMI of more than 30) with shorter sleep duration have twice as many subjective sleep problems compared to non-obese people [*Int J Obes (Lond). 2008 May; 32(5):801-9*].
- Being obese or overweight is associated with decreased amount of sleep compared to non-obese patients [*Vorona RD, Winn MP, Babineau TW, Eng BP, Feldman HR, Ware JC;Arch Intern Med. 2005 Jan 10; 165(1):25-30*].
- Obesity is associated with poor sleep quantity and quality; thus weight reduction can ameliorate sleep problems [*Vorona RD, Winn MP, Babineau TW, Eng BP, Feldman HR, Ware JC; Arch Intern Med. 2005 Jan 10; 165(1):25-30*].

Hormonal Imbalances with Poor Sleep

- Decrease in melatonin leads to alterations in the metabolic circadian rhythm predisposing to weight gain and metabolic syndrome [*Baron KG; Int J Obes (Lond). 2017 Feb; 41(2):203-209*].
- Alterations in the actions of the hormones leptin and insulin. Obese individuals develop resistance to both of these hormones.
- These hormones decrease food need and increase energy metabolism.
- Ghrelin stimulates appetite and is also affected by sleep disturbances.
- An increase in the level of ghrelin and a decrease in the level of leptin is also noted in chronic short sleepers. These altered levels in short sleepers predispose to obesity because of the associated increased food intake.[*Gastroenterology. 2003 May; 124(5):1532-5.]*

Role of Leptin and Ghrelin in OSA and Obesity

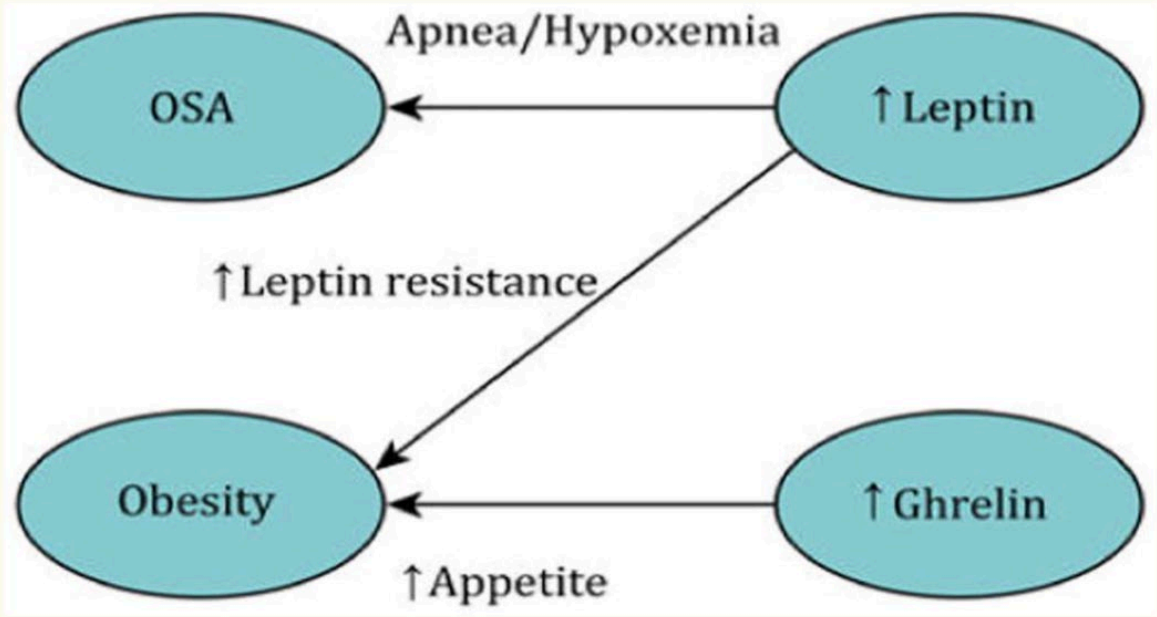


Figure 2

A schematic diagram that shows the correlations between OSA, Obesity, Leptin, and Ghrelin.

Associated Medical Conditions

- Hypertension
- Pulmonary Disorders
  - Pulmonary hypertension
  - Asthma & COPD
- Cardiac Disorders
  - Ischemic heart disease
  - Arrhythmia
- Neurological Disorders
  - Cerebrovascular disease
  - Parkinson’s disease
- Endocrinological Disorders
  - Hypothyroidism
  - Acromegaly
- Hematological Disorders
  - Sickle cell disease

Figure 1

A schematic diagram that shows the obesity and associated comorbidities.

Risk Factors for OSA

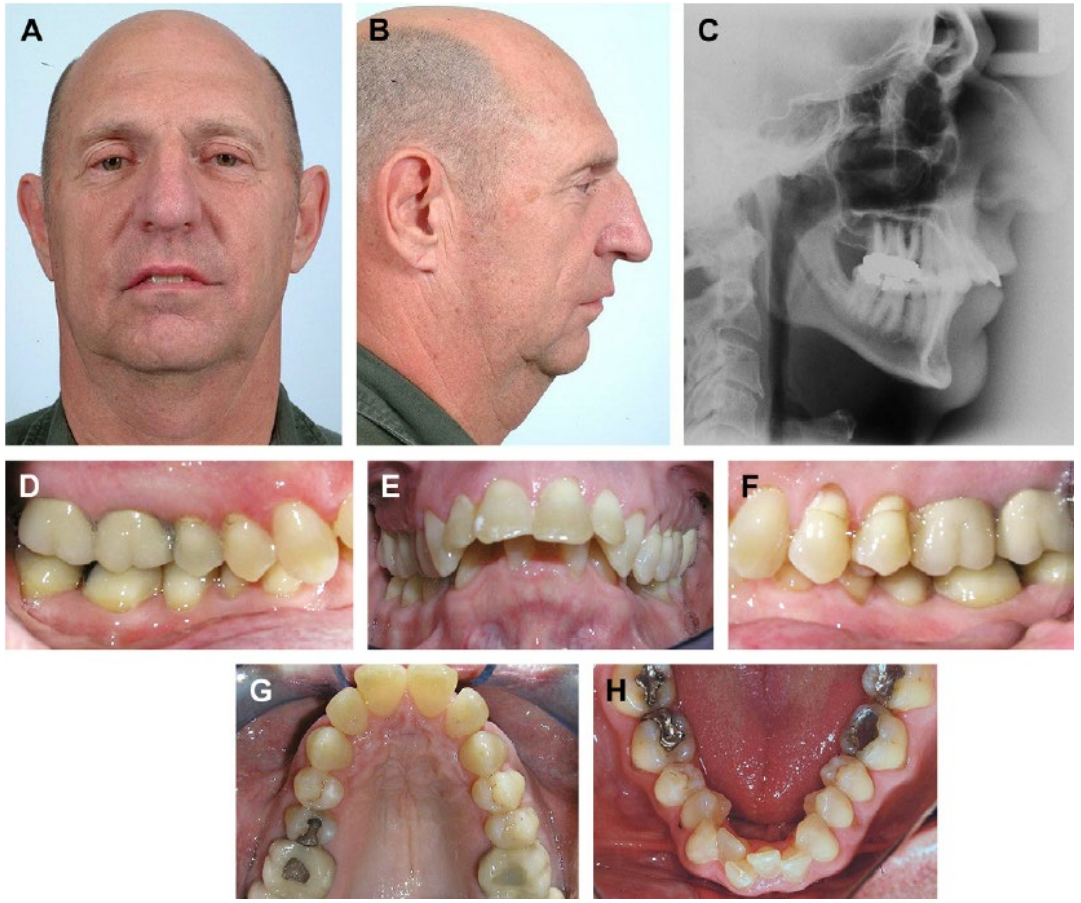
- Obesity (BMI > 28)
  - 60-90% of people with OSA
- Male gender
  - 2-3 : 1 in community studies
  - 10-90 : 1 in clinic-based studies
- (+) family history
  - 2-4x more likely
- Race
  - ↑ in African American, Mexican, and Pacific Islander populations
- Substances
  - Alcohol, tobacco, sedatives
- Aggravating factors
  - Nasal congestion, supine sleeping position, sleep deprivation
- Disorders
  - Marfan syndrome, Down syndrome, Pierre-Robin sequence

Symptoms

- Nocturnal
  - Snoring
  - Witnessed apnea
  - Choking
  - Dyspnea
  - Restlessness
  - Nocturia
  - Diaphoresis
  - Reflux
  - Drooling
- Daytime
  - Sleepiness
  - Fatigue
  - Morning headaches
  - Poor concentration
  - Decreased libido or impotence
  - Decreased attention
  - Depression
  - Decreased dexterity
  - Personality changes

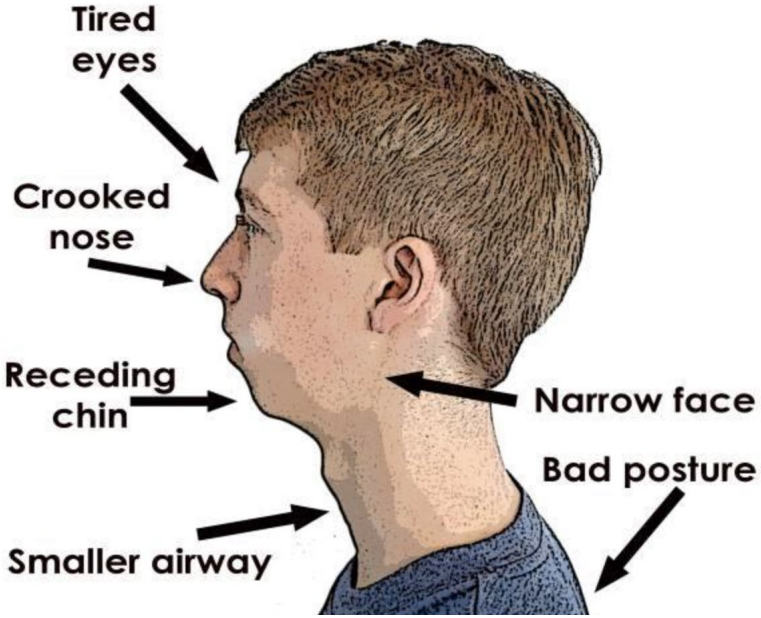
Exam

- Vitals
  - BMI
  - Neck circumference
- ENT
  - Cranial
  - Nose
  - Mouth
- Heart
- Lungs
- Extremities
- Neurological

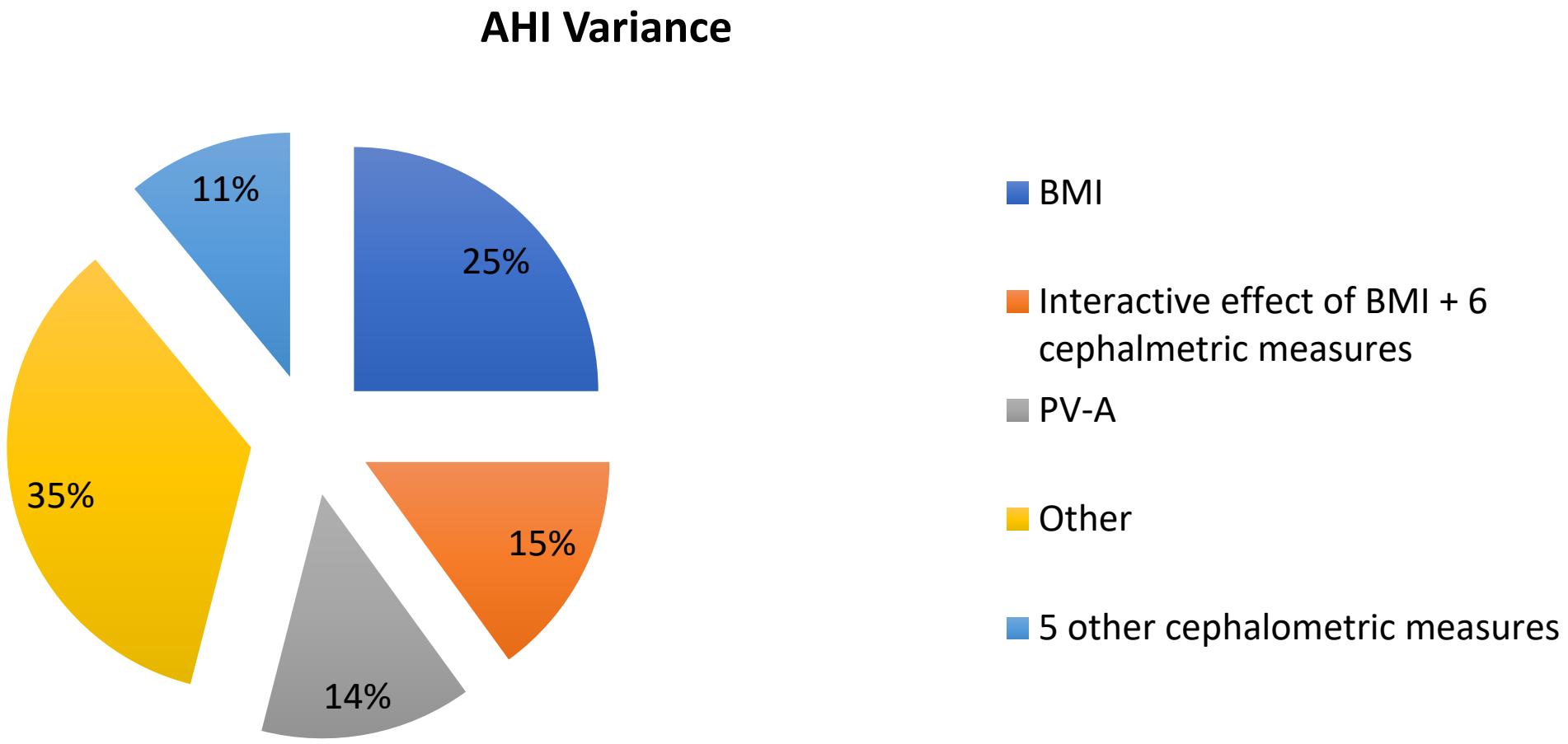


Cephalometrics

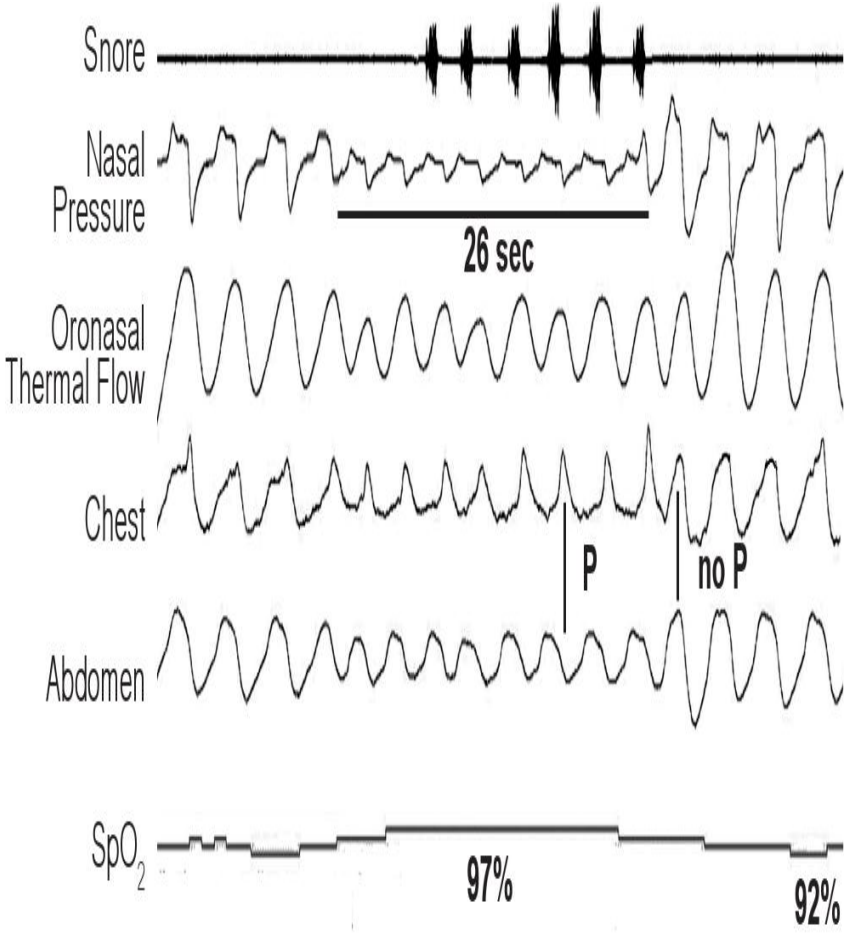
- Upper Airway
  - Bone
    - Septal deviation
    - Turbinate enlargement
    - High arched palate
    - Maxillary insufficiency
    - Micro/retrognathia
  - Soft tissue
    - Long soft palate
    - Large tongue
    - Large neck circumference
    - Tonsillar and adenoid hypertrophy
    - Obesity
  - Genetic

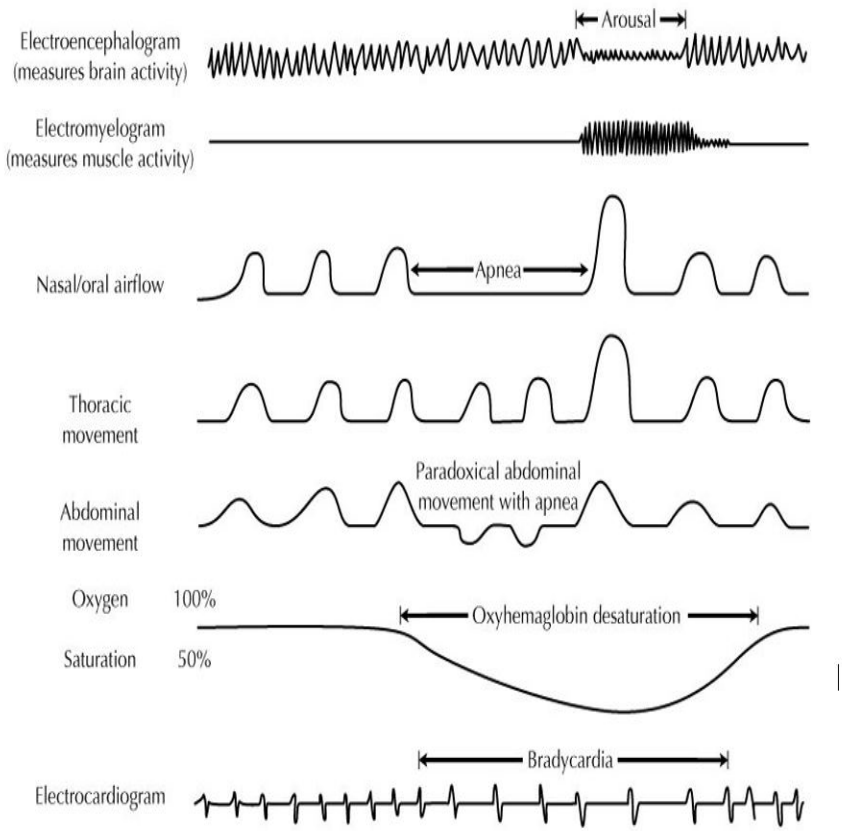


Wisconsin Sleep Cohort (n=204)



Polysomnography



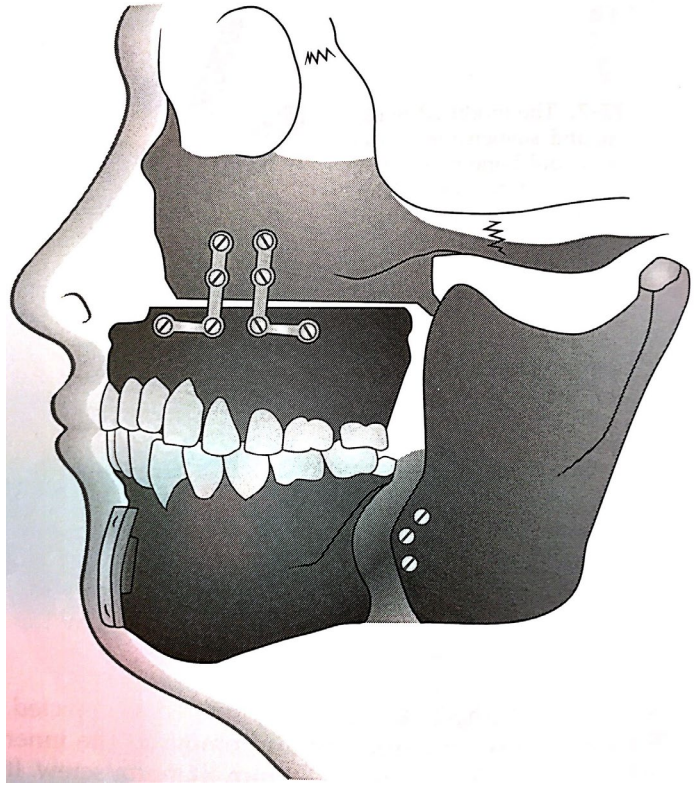


Warvedaker NV et al. Best Practice of Medicine. Sept. 1999

Treatment options

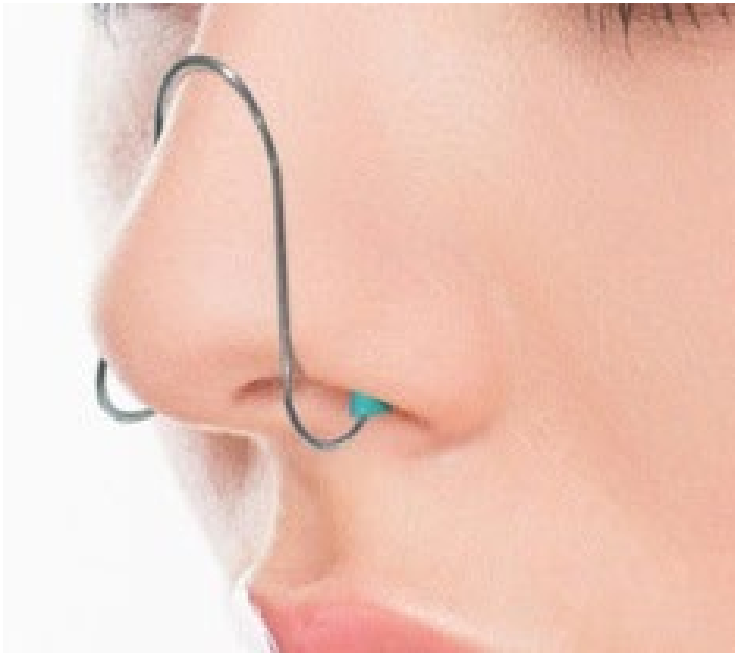
- **CPAP-** The conventional treatment. This therapy uses a machine to deliver a constant airflow to a patient's airway via a nasal, facial, or oral device that maintains airway patency during sleep.
- **Weight loss by surgical procedures**
- **Medical weight loss**

Primary Therapies



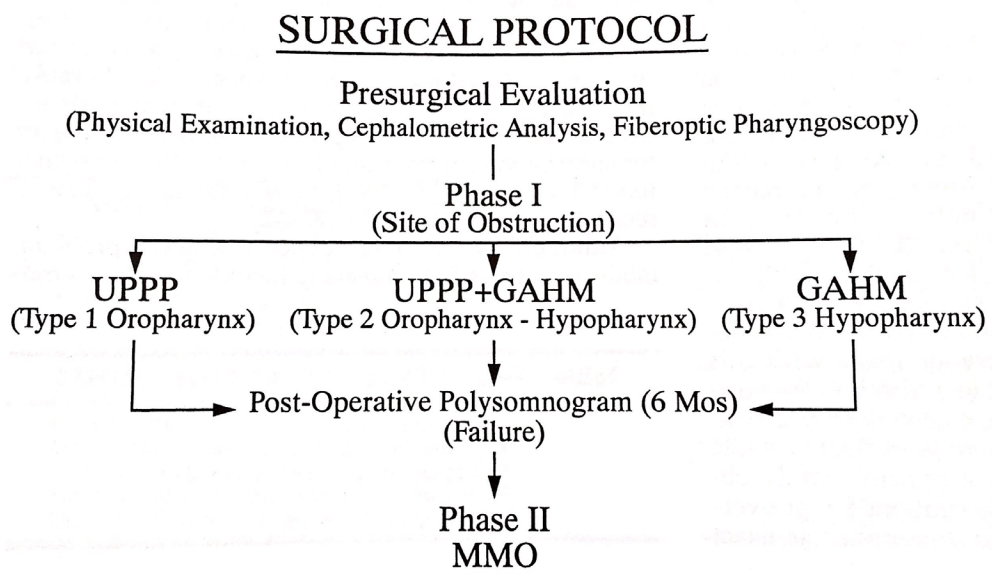
Medical Management

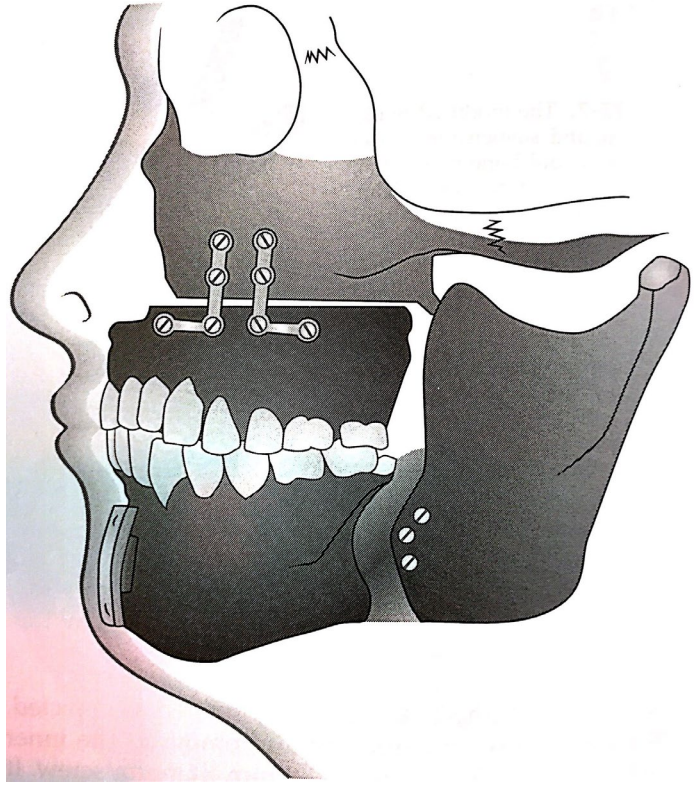
- Weight loss
  - Counseling
  - Dietitian
  - Medical weight loss
  - Surgical weight loss
- Allergies
  - Sinus rinses, nasal steroid, vasoconstrictor
  - Allergy / ENT
- Positional therapy
  - Correlate with PSG
  - Devices available but uncomfortable
  - Perception ≠ reality
- Myofunctional Therapy
  - Poor adherence
- Remove offending agents
  - Alcohol, smoking, sedatives, testosterone
- Medications
  - Stimulants
  - REM suppressants, ↑ pharyngeal tone
- Nasal dilators / intubation
- Nasal EPAP




surgilube

Surgical Therapy





Therapeutic Challenges

- Oral appliance: 77 patients, over 11 years, increased incidence of anterior crossbite and posterior open bite which was progressive in nature.
- CPAP: 29-83% non-adherence rate (average nightly use < 4 hours).
- MMA: 518 patients, “treatment paradox,” cure rate (AHI < 5/hour) 56% if AHI < 30/hour, 20% if AHI > 90/hour.

Weight Loss and Sleep Apnea

Well what if I lose weight? Will that help?

Randomized control trial, 60 patients, average BMI 45, OSA (average AHI 61) on CPAP, gastric banding vs. diet and exercise, 2 year follow-up

Medical Weight Loss

- Average Weight Loss: 5 kg
- AHI reduction: 14/hour

Surgical Weight Loss

- Average Weight Loss: 28 kg
- AHI reduction: 26/hour

10 patients AHI < 15/hour, 1 patient AHI < 5/hour “cure”

Weight Loss and Implications on Health

Diagnosis	Weight loss target %	Expected outcome
Metabolic syndrome	10	Prevention of type 2 diabetes
Type 2 diabetes	5–15	Reduction in HbA1c; reduction in diabetes mediication; diabetes remission if short duration
Dyslipidaemia	5–15	Lower triglycerides; increase HDL, decrease LDL
Hypertension	5–15	Lower blood pressure; decrease in medication
NAFLD	10–40	Reduction in intrahepatocellular lipids and inflammation

Diagnosis	Weight loss target %	Expected outcome
PCOS	5–15	Ovulation; reduction of hirsutism; decrease in androgen ieveis; increase insulin sensitivity
Sleep apnoea	7–11	Decrease apnoea/hypopnoea index
Asthma	7–8	Improvement of FEV1
GERD	≥10	Reduced symptoms

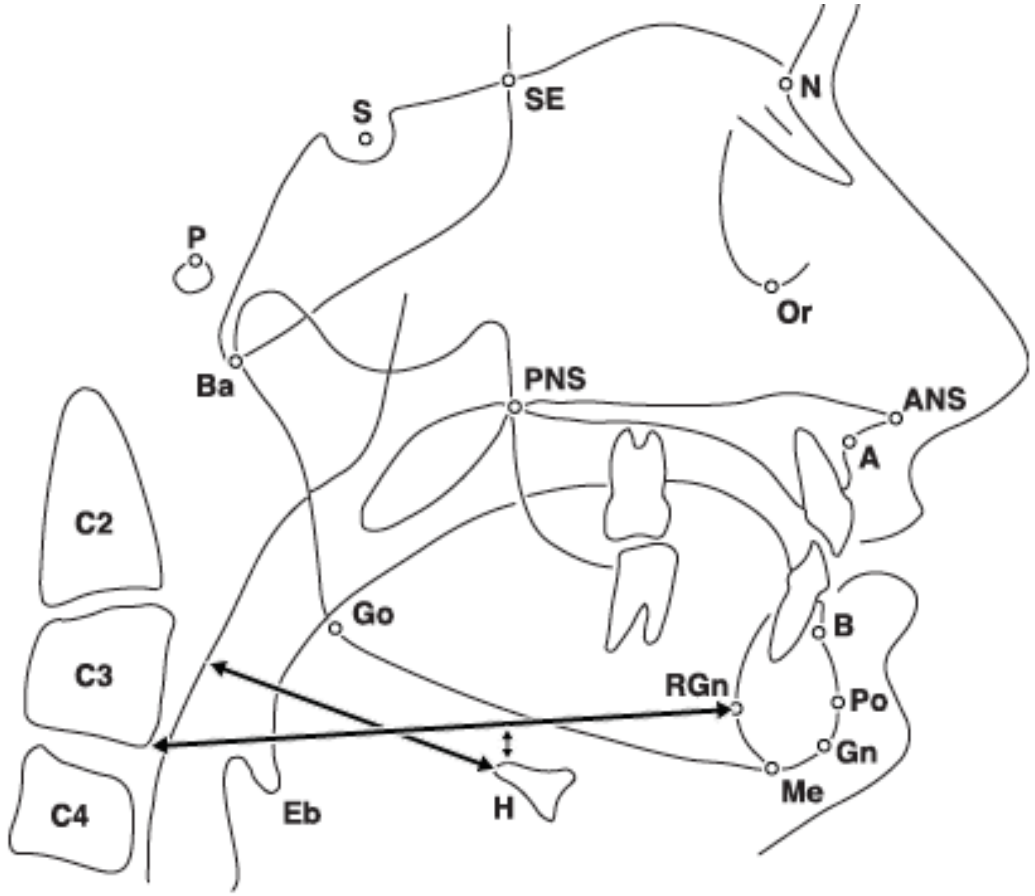
Note that weight loss will depend upon the nature of complication. FEV1, forced expiratory volume at 1s; GERD, gastroesophageal reflux disease; HDL, high density lipoprotein; LDL, low density lipoprotein; NAFLD, non-alcoholic fatty liver disease; PCOS, polycystic ovary syndrome.

Knowler WC, Barrett-Conner E et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med. 2002;346:393-403.

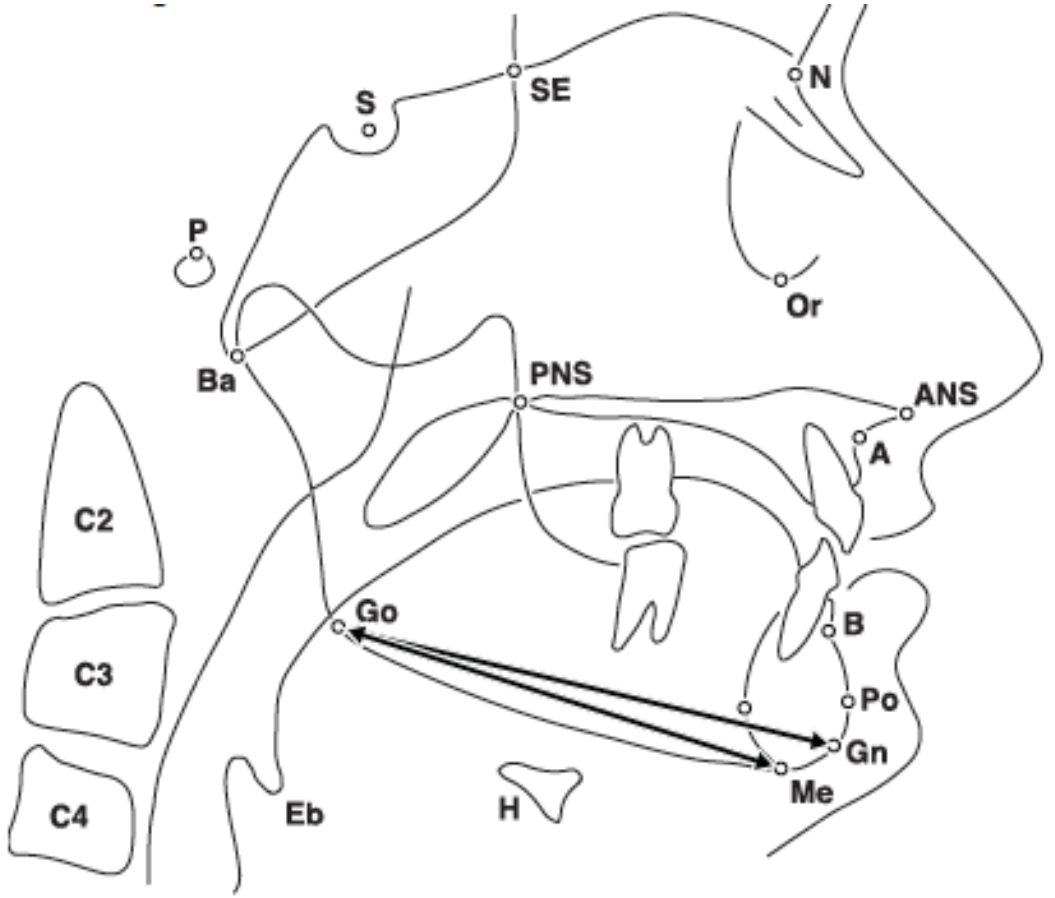
Shorter Mandibular Length is Associated with a Greater Fall in AHI with Weight Loss

Naughton MT, Monteith BD, Manton DJ, Dever P, Schachter LM, O'Brien PE, Dixon JB.

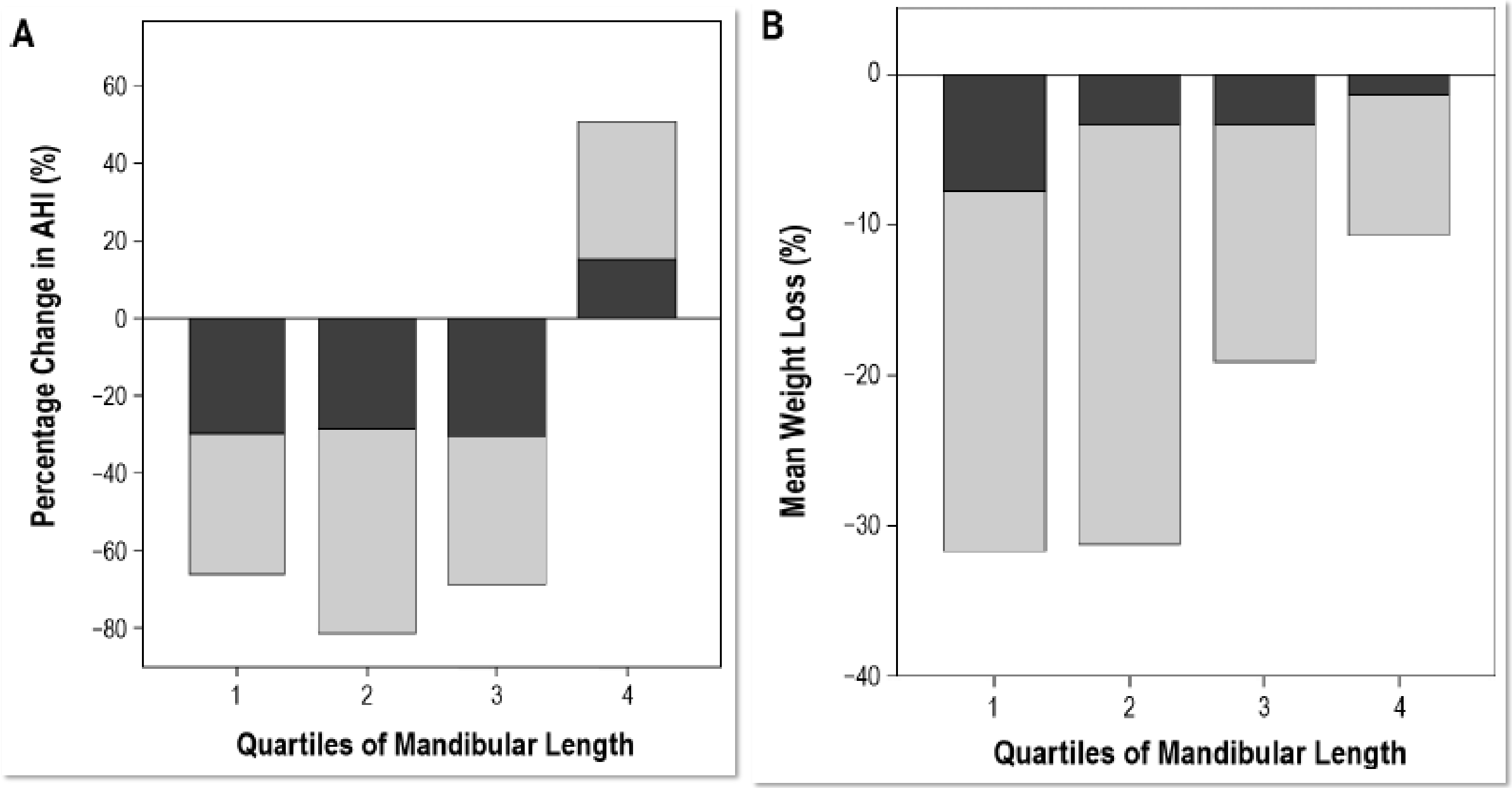
Journal of Clinical Sleep Medicine



- Hyoid perpendicular-C3-retrognathion (r = 0.37, p = 0.004); hyoid-posterior pharyngeal wall (r = 0.47, p < 0.001)



- Gonion-gnathion; gonion-menton


A
Percentage Change in AHI (%)
60
40
20
0
−20
−40
−60
−80
1
2
3
4
Quartiles of Mandibular Length
B
Mean Weight Loss (%)
0
−10
−20
−30
−40
1
2
3
4
Quartiles of Mandibular Length

Take Home

- Neck circumference indicative of baseline AHI in pre-intervention obese patients
  - No other cephalographic measure provided additional contribution to variance
- Higher % change in weight loss and shorter mandibular length contributes to AHI variance at 2 years post-bariatric intervention.

Summary

- In obese people fat deposits in the UR tract narrows the airway leading to hypoxia and apnea.
- OSA causes hypoxic injury
- Hypoxia drives CV risk (TNF alpha, CRP, IL6)
- greater weight gain had a more severe apnea-hypopnea index (AHI)

Summary

- Hormonal imbalance with poor sleep (decrease melatonin, insulin and leptin resistance, increase ghrelin.)
- Therapy options for OSA
- Impact of wt loss on Health and outcomes