

OBSTRUCTIVE

SLEEP

APNEA

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DEFINITION

It takes its name from the Greek word *apnea*, which means "without breath." Sleep apnea means "cessation of breath." It is characterized by repetitive episodes of upper airway obstruction that occur during sleep, usually associated with a reduction in blood oxygen saturation.

People with sleep apnea literally stop breathing repeatedly during their sleep, often for a minute or longer and as many times.

INCIDENCE

Estimated to affect 2% of middle-aged women and 4% of middle-aged men.

HISTORY OF OSA

In 1918 Sir William Osler coined the term "Pickwickian" to refer to obese, hypersomnolent patients. In 1956 Dr. Burwell and colleagues in describing several obese, hypersomnolent patients with respiratory and cardiac failure coined the term "Pickwickian Syndrome". It wasn't until 1965 that a French group of investigators, Dr. Gastault and colleagues made the important observation that "Pickwickian" patients had repetitive apnea events while asleep.

Following this, Dr. Kuhlo and colleagues (1969) described a marked improvement in patients treated with tracheostomy. In 1978, Dr. John Remmers described the interaction between sleep, the breathing muscles of the chest, and the muscles of the upper airway which explained why the upper airway collapses during sleep, leading to obstructive sleep apnea.

APNEA

An apnea is defined as a cessation of airflow that lasts at least ten seconds.

HYPOPNEA

A hypopnea is defined as a significant reduction in airflow lasting at least ten seconds..Hypopnea is a 30% or greater reduction in flow associated with a 4% drop in oxygen saturation.

RDI INDEX

The American Academy of Sleep Medicine (AASM) rates the average number of obstructive sleep apnea events per hour as Respiratory Distress Index (RDI).

An RDI of 0 to 5 is normal

5 to 20 is mild

20 to 40 is moderate

over 40 is considered severe

SYMPTOMS

Excessive daytime sleepiness ,frequent episodes of obstructed breathing during sleep. Because many patients are not aware of their heavy snoring and nocturnal arousals, it is helpful to question the bedroom partner.

Associated features may include:

Loud snoring

morning headaches

unrefreshing sleep,

a dry mouth upon awakening

chest retraction during sleep in young children (chest pulls in)

high blood pressure,

overweight

irritability,change in personality

depression ,difficulty concentrating

excessive perspiring during sleep ,heartburn,

reduced libido ,insomnia

frequent nocturnal urination (nocturia),

restless sleep,nocturnal snorting, gasping, choking (may wake self up)

rapid weight gain,confusion upon awakening .

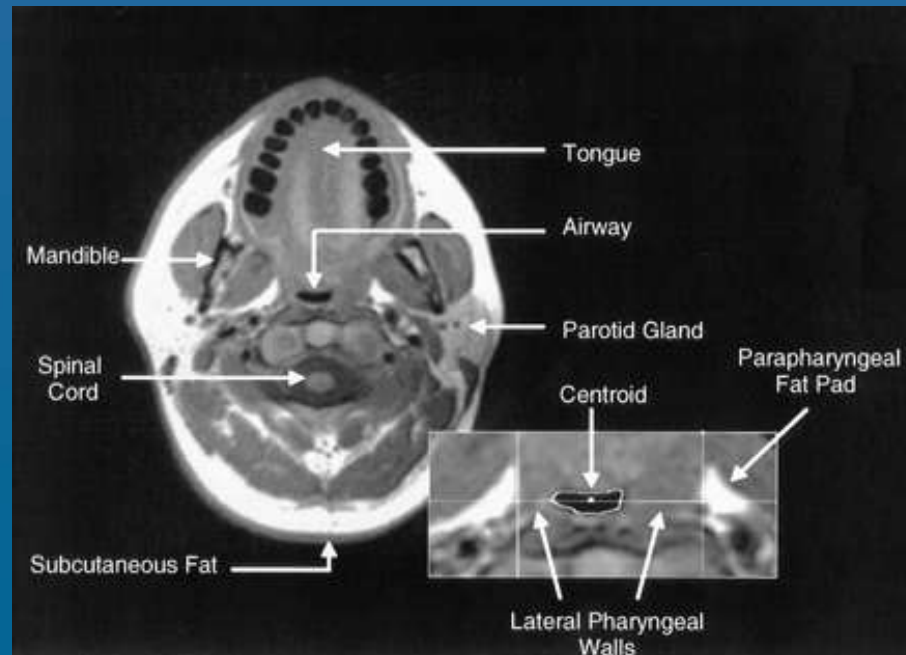
PATHOGENESIS

During inspiration a negative intrapharyngeal pressure develops but airway collapse is prevented by the action of the pharyngeal abductor and dilator muscles. These muscles are activated rhythmically during daytime respiration but, they become hypotonic during sleep, and airway stability becomes dependent upon pharyngeal size and pharyngeal tissue compliance. Apnea occurs when the throat muscles and tongue relax during sleep and partially block the opening of the airway. As yet, little is known about the compliance of the pharyngeal tissues. However, conditions that reduce airway dimensions result in OSA.



PREDISPOSING FACTORS

1. Age due to loss of muscle mass is common and replacement with fat, leaving the airway narrow and soft.
2. Men have a greater risk for OSA.
3. Retropositioned maxilla and mandible
4. Obesity Rivlin suggested that parapharyngeal deposition of fat may have contributed to sleep apnea.



5. Habitual snoring – Many, but not all individuals with sleep apnea experience symptoms of snoring, gasping, and choking during sleep.
6. Family history – Inherited characteristics in the face and neck can cause breathing abnormalities.
7. Immune abnormalities – IL-6 and TNF-alpha may both play a role in obesity as well.
8. Individuals with severe heartburn (Gastroesophageal reflux disease, or GERD) appear to be at higher risk.
9. Enlarged tonsils and adenoids, the main causes of OSA in children

11. Drugs - increases the degree of relaxation of the upper airway muscles and interfere with the brain's arousability

a. Alcohol

b. Sedative drugs (eg. benzodiazepines - valium, ativan)

c. Sleeping pills

d. Anaesthetics

e. Narcotics (codeine, morphine)

12. Smoking, which can cause swelling of the upper airway

13. Hypothyroidism, acromegaly, amyloidosis, vocal cord paralysis, Marfan's syndrome, and Down syndrome

14. Nasal congestion

15. Neuromuscular disorders such as postpolio syndrome can result in inadequate neuromuscular control of the upper airway and lead to obstructive sleep apnea.

TYPES OF APNEA

1. OBSTRUCTIVE APNEA

2. CENTRAL APNEA

3. MIXED APNEA

Obstructive sleep apnea is characterized by the cessation of airflow with persistence of ventilatory effort, caused by collapse of soft tissue structures in the oropharynx or hypopharynx.

Possible Sites of Obstruction

Nose:

- Deviated septum
- Enlarged turbinates
- Polyps

Nasopharynx:

- Enlarged adenoids

Pharynx:

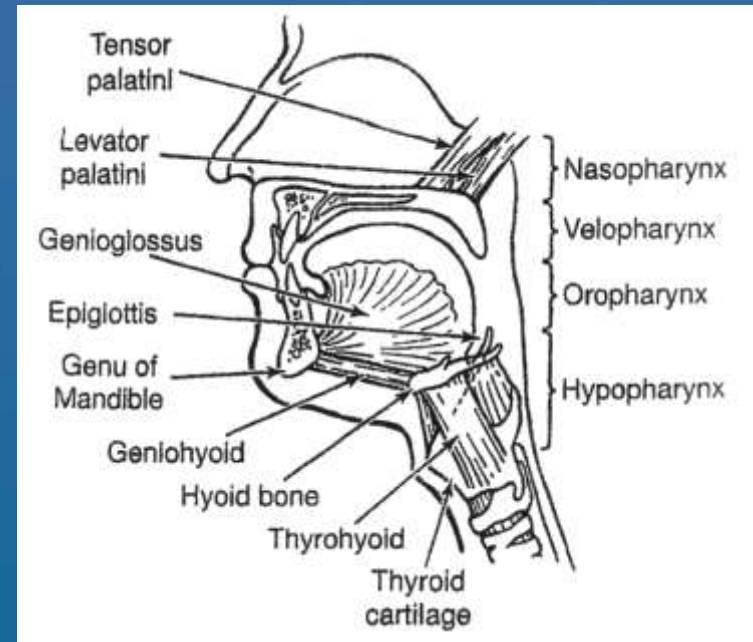
- Enlarged tonsils
- Enlarged uvula or soft palate
- Enlarged base of the tongue
- Tongue base falling into pharyngeal airway
- Submucosal fat or redundant mucosa

Larynx (voice box):

Laryngopharyngeal reflux changes with severe posterior commissure swelling

MAIN SITE OF OBSTRUCTION

Most of the obstructions were seen in the retroglossal and retropalatal tissues of the oropharynx.



CENTRAL APNEA

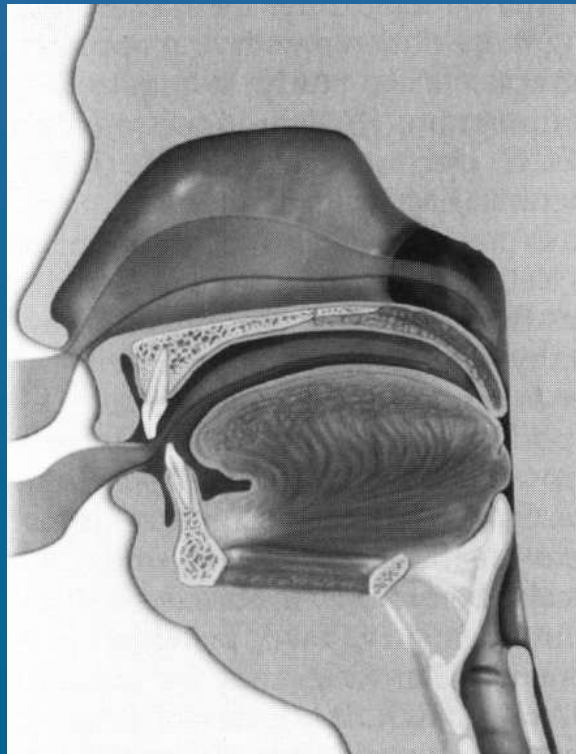
Central sleep apnea (CSA) occurs when the brain fails to send the appropriate signals to the breathing muscles to initiate respirations. It is often secondary to central nervous system diseases, such as infarction and infection involving the brain stem, or neuromuscular diseases involving respiratory muscles. In primary alveolar hypoventilation and obesity hypoventilation syndrome (eg, Pickwickian Syndrome), there is a reduction of ventilatory chemosensitivity and a decrease in central ventilatory drive. In some cases, CSA is a component of periodic breathing (eg, Cheyne-Stokes respiration) This type of apnea is common to neurological injury. Rarely, sleep apnea is due to primary brain stem medullary failure or **Ondine's curse-**

First, evidence of central sleep apnea has been observed (Badr, 1995)
Central breathing instability has been well established to contribute to the development heart failure (Leung, 2001; Xie,2002; Xie, 1995).

MIXED APNEA

Mixed apnea starts as unobstructed apnea, which is quickly followed by thoracoabdominal movements with upper airway obstruction. Mixed apnea starts as central apnea, quickly followed by thoracoabdominal movements and upper airway obstruction.

Mixed apnea occurs more often than central but less often than obstructive apnea; it should be treated as an obstructive apnea.



CYCLE DURING SLEEP IN OSA

NORMAL CYCLE.

Initially, light sleep or stage 1 of Non-REM sleep occurs and usually within 5 to 20 minutes go into a deeper sleep or stage 2. The deepest sleep is stage 3 and 4

Non-REM sleep. As we go into the deeper stages of sleep we become less arousable and the body's muscles become more relaxed. Normally REM sleep occurs more often and for longer periods in the early morning hours

IN OSA PATIENTS

Their breathing disturbance markedly interferes with their normal sleep patterns such that they may wake up very briefly but frequently, thus spending a majority of their sleeping time in Stage 1 and 2 Non-REM sleep and much less in Stage 3-4 and REM sleep. The result is that many people complain of a very unrefreshing sleep.

Apneas tend to be more common and more severe during REM compared with Non-REM sleep

How is Normal Breathing Restored During Sleep

During the apneic event, the person is unable to breathe in oxygen and to exhale carbon dioxide, resulting in low levels of oxygen and increased levels of carbon dioxide in the blood. The reduction in oxygen and increase in carbon dioxide alerts the brain to resume breathing through upper airway muscles; breathing is resumed, often with a loud snort or gasp. Frequent arousals, although necessary for breathing to restart, prevent the patient from getting enough restorative, deep sleep.

SEQUELA

Results in excessive daytime sleepiness, performance and cognitive decrements, and cardiovascular dysfunction that include systemic hypertension, right heart failure, and cardiac arrhythmias. The risks of undiagnosed obstructive sleep apnea include heart attacks, strokes, impotence, irregular heartbeat, high blood pressure due to apnea induced increased sympathetic nervous activity. The most obvious complication arising from OSA is diminished quality of life brought on by chronic sleep deprivation .

DIAGNOSIS

EVALUATION - The way to find these patients is to be aware of the common signs and symptoms of obstructive sleep apnea and to carefully examine any patient who complains of snoring or daytime sleepiness.

PHYSICAL EXAMINATION

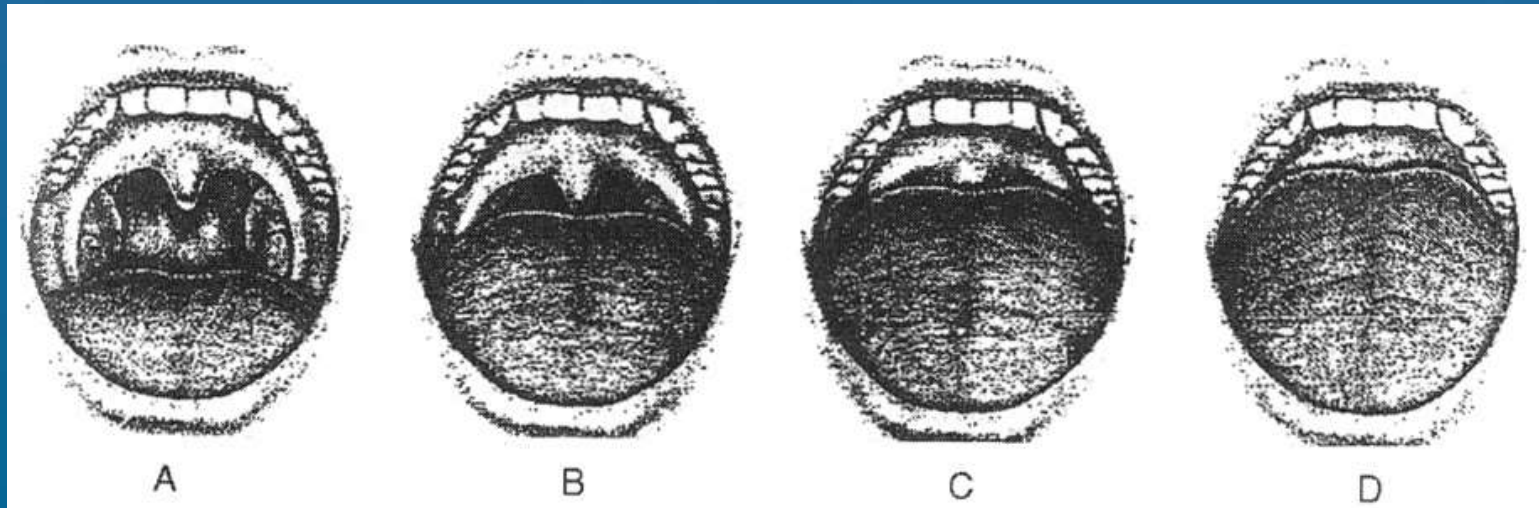
The physical examination is frequently normal in OSA, other than the presence of obesity (defined as a body mass index greater than 28 kg/m²) and neck diameter greater than 16 inches.



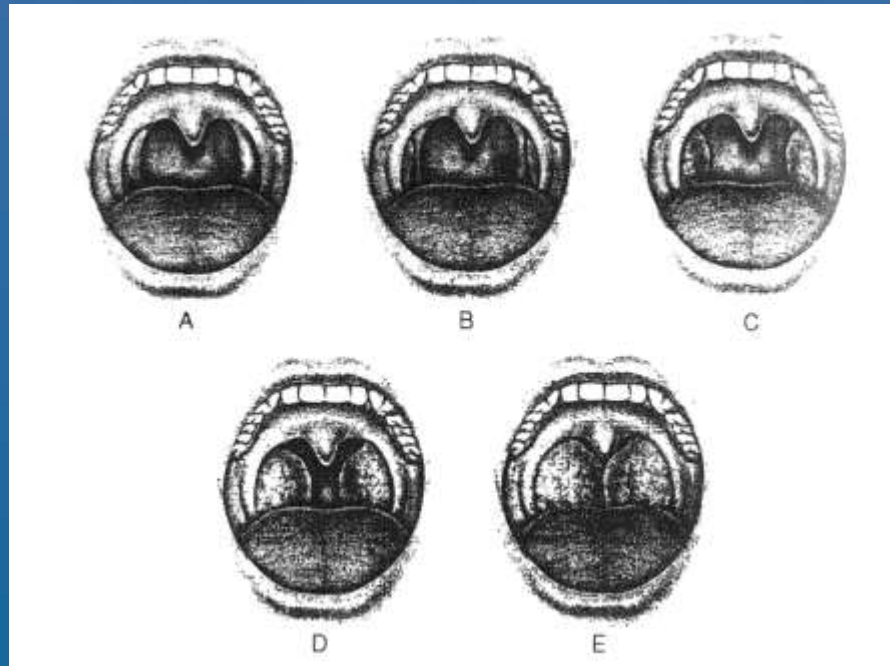
ORAL EXAMINATION

The upper airway should be evaluated in all patients, particularly in nonobese adults with symptoms consistent with OSA.

Malpanti scores used in anesthesia for determining the difficulty of performing an intubation as the tongue obstructs the airway is used to evaluate OSA. Scores of 3 and 4 are at a greater risk of sleep apnea.



Enlarged tonsils-tonsil size is graded on a universally recognized standard.



Retrognathia or micrognathia

Soft palate edema/erythema

High, arched hard palate

These patients may have an enlarged floppy uvula or tonsillar hypertrophy .

An elongated soft palate that rests on the base of the tongue is another cause of the airway obstruction sometimes seen in patients with sleep apnea

A suggested self-administered screening questionnaire is presented as

The Epworth Sleepiness Scale

The chances of dozing off in the each of the following situations are rated
Sitting and Reading, Watching TV, Sitting inactive in a public place such as a theater or meeting, as a passenger in a car for an hour without a break, lying down to rest in the afternoon when circumstances permit, sitting and talking to someone, sitting quietly after a lunch without alcohol, in a car stopped for a few minutes in traffic.

- 0 - No Chance of Dozing
- 1 - Slight Chance of Dozing
- 2 - Moderate Chance of Dozing
- 3 - High Chance of Dozing

More than 10 is considered to be pathological and Epworth Sleepiness Scale indicates that sleep specialist should be consulted. ESS is useful in evaluating response to treatment. The ESS should decrease with effective treatment

POLYSOMNOGRAPHY

It is considered the gold standard of sleep apnea diagnosis.

A sleep technician administers the study.

Sleep polysomnography features electrocardiography/EKG, brainwave electroencephalography/ EEG measurements, motor activity extremity measurements, diaphragmatic/chest movement, eye movement, pulse oximetry for oxygen desaturation measurement, and inhalational/exhalational oro-nasal flow characteristics

All the information collected provides a detailed account of the number and severity of the apneas/hypopneas occurring during sleep and their effects on the body's oxygen level, sleep stages as well as arousals.



Polysomnography (sleep study).

Criteria include:

- 1.Cessation of air flow for 10 seconds even with maintenance of respiratory effort.
- 2.Five or more episodes of apnea per hour.
- 3.Decrease in oxygen saturation of at least 4% during episodes.

Disadvantage

- 1.Sometimes, however, a patient does not sleep long enough to obtain all the data needed.
- 2.Polysomnography can not provide data from patients who have mild OSA only at home or only after using certain medications or alcohol but who do not experience any episodes during the sleep study. Therefore, a polysomnogram must be interpreted with the entire clinical picture in mind.
3. polysomnography is expensive and labor intensive

EMG ACTIVITY

GENIOGLOSSUS

An increased size, altered shape, more upright posture and caudal extension facilitates the tongue's fall backward due to gravity when OSA patients move from upright to supine position. Pae AOO2000

GG activity is reduced during sleep and such a reduction in tone might result in a thickening of the muscle or posterior movement of the tongue (Wheatley 1993. *Am. Rev. Respir. Dis.*). Women appeared to show a higher GG baseline EMG activity during spontaneous breathing at rest, while men were more responsive to the partial occlusion of the pharyngeal airway. Pae, Ravindra Nanda, AJO 2002

PHARYNGEAL WALLS

Kuna evaluated the electromyographic activity of the pharyngeal constrictor muscles in normal adults during wakefulness and sleep. However, their finding of decreased electromyographic activity of these muscles during sleep indicates a reduction in their tone. (Kuna, S. T 1997 *Am. Rev. Respir.*)

OXIMETRY

Severe apnea is often associated with significant arterial desaturation, it may be possible to use simple and inexpensive pulse oximetry as a screening method for the most severe disease. Overall, home evaluation is useful when the results are clearly positive. However, negative results do not rule out the presence of a sleep disorder.

Continuous nocturnal oxygen saturation measurement at home.

Using 10 desaturations per hour as the cutoff, it has a 98% sensitivity but only a 48% specificity with a positive predictive value of 61% and a negative predictive value of 97% in those with a history suggestive of sleep apnea.

Disadvantages

1. Not valid in those receiving oxygen therapy
2. Can be used to screen before ordering a sleep study, since it has a high negative predictive value and is inexpensive



MULTIPLE SLEEP LATENCY TEST

The Multiple Sleep Latency Test (MSLT) measures the speed of falling asleep. A multiple sleep latency test may also be performed to assess the level of daytime sleepiness. The average adult requires 10 or more minutes to fall asleep during the day. A mean sleep latency of less than 5 minutes is considered abnormal. The MSLT may be useful to measure the degree of excessive daytime sleepiness and to rule out other types of sleep disorders.

MSLT consists of 4-5 naps of 20 minutes duration every 2 hours during the day. The latency to sleep onset for each nap is averaged to determine the daytime sleep latency. Normal daytime sleep latency is greater than 10-15 minutes. OSA is generally associated with latencies less than 10 minutes.

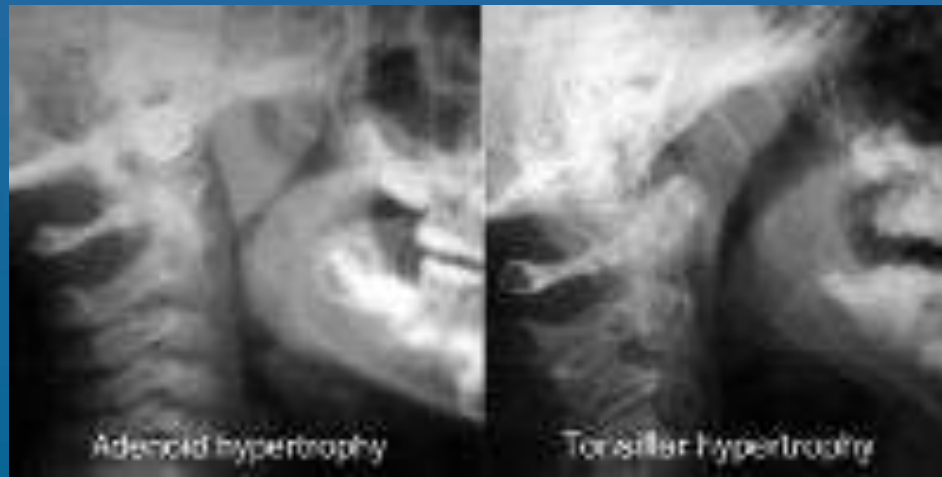
PULMONARY FUNCTION TESTS

Pulmonary function tests should be obtained if any evidence of cor pulmonale is noted or if the nocturnal symptoms are suggestive of nocturnal asthma.

INVESTIGATIONS

RADIOGRAPHS

Radiographic studies that have been found to be useful include lateral neck films that can demonstrate adenotonsillar hypertrophy and some other airway lesions. The significant advantages of cephalometry are its easy access, low cost, and minimal radiation. The exposure should be taken at the end of the expiration



CEPHALOMETRIC VALUES

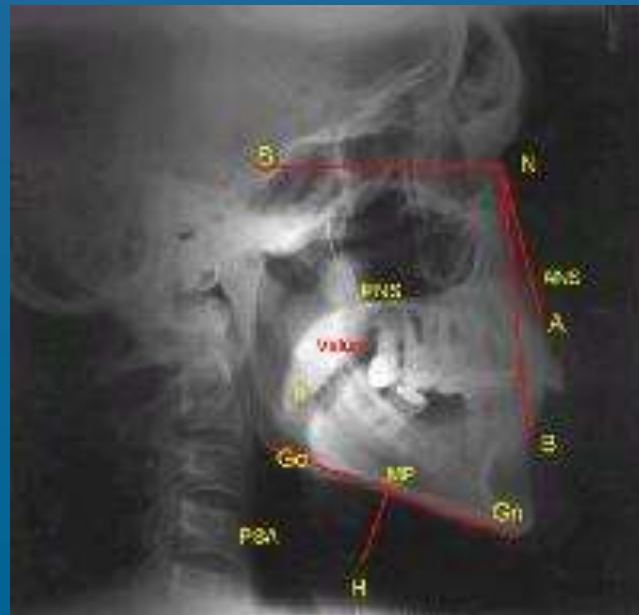
MP-H is the distance between the mandibular plane and the hyoid bone. The reference range is 11-19 mm. The longer the distance, the higher the possibility of the patient having OSA.

PSN-P is the length of the velum of the palate. The reference range value is 37 ± 3 mm.

G is the width of the velum of the palate. The reference range is 6-10 mm

PAS is the PAS or retroglossal space; the reference range is 10-16 mm

Retropalatal space is the narrowest measurement between the posterior surface of the velum of the palate and the posterior pharyngeal wall.



CEPHALOMETRIC CHARACTERISTICS OF OSA

Common clinical and radiographic characteristics (ALAN LOWE)

(1) Mandibular retrognathia, (2) retruded maxilla, (3) posterior vertical maxillary deficiency, (4) retropositioned tongue, (5) high mandibular plane angulation, (6) short chin-neck line, (7) decreased PAS (8) poor definition of gonial angles (9) Class II dental occlusion (but sometimes Class I) (10) steeper and shorter anterior cranial base (11) longer soft palate

Some other characteristics that may be seen in these patients are nasal airway obstruction (ie, narrow nostrils, wide columella, enlarged turbinates, deviated septum, polyps, nasopharyngeal adenoid tissue, decreased posterior choanal height, etc) and oropharyngeal abnormalities (elongated soft palate, medially and posteriorly positioned posterior faucial pillars, enlarged adenoids, hyperplastic tonsils, macroglossia, etc).

Riley et al found that a PAS of less than 11 mm and a mandibular plane-hyoid bone angle greater than 15.4° was indicative of OSA .

CHANGES IN SUPINE

Supine films provide a more realistic anatomical picture of the airway and surrounding structures. The soft palate and tongue occupy a larger proportion of the airway in this position and the hyoid moves anteriorly and inferiorly in both snorers and OSA subjects as shown by Battagel, Ama Johal EJO 2002.

Supine lateral skull films were obtained using an adjustable Orbix machine. Subjects lay supine with a foam head support placed in a position that resembled as closely as possible that which they adopted during supine sleep. Contrast medium was applied to the tongue and the subjects were asked to place their teeth in light occlusion. Lateral head position was carefully aligned and all films were taken at end-expiration. This procedure was adopted because it was not possible to obtain supine recordings using the cephalostat. (Joanna M. Battagel, Ama Johal Angle 2002)

HYOID POSITION

A descending position of the hyoid with increasing age is due to the tongue's increasing in bulk and becoming larger in relation to the intermaxillary space, a trend that is pronounced in males. This jeopardizes the volume and resistance of the upper airway. Inferior hyoid bone position in patients with OSAS may be a secondary effect because of an attempt to maintain patency of the upper airway passage (Solow et al. and Tangugsorn)

CRANIOCERVICAL ANGLE

Apneic subjects had a craniocervical extension and forward head position compared with nonapneic subjects as it was found to enlarge the airway (lower oropharyngeal and hypopharyngeal levels) Tangugsorn V. Eur J Orthod 1995 AOO2000 . Ozbek Lowe Eur J Orthod 1998;

SNORING AND OSA

The snoring sound is produced by the vibration of the soft palate or other oropharyngeal tissues.

Middle cranial fossa (MCF) measurement values were smaller in snorers than in nonsnorers; It is likely that MCF, which is an estimate of the bony dimensions of the upper pharyngeal space, might be smaller in people from childhood and might predict future habitual snoring and apneic activity. Snorers exhibit an inferior hyoid position from the time of childhood Suchitra Nelson AJO 2003

Not everyone who snores has apnoea and not everyone with apnoea necessarily snores.



CT

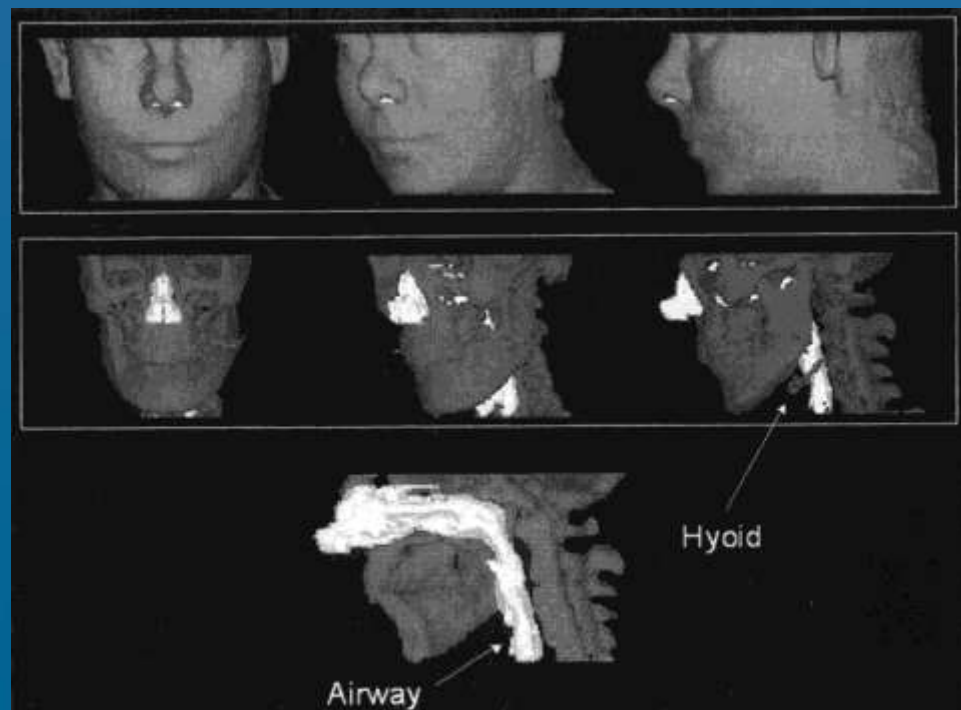
Crumley, et al in 1987 reported that cine-computed tomography may be a useful dynamic radiologic study for the determining the obstructive site. CT scanning produces excellent resolution of images to evaluate both the soft tissue and the osseous structures of the pharynx-larynx complex. It has the advantage of producing axial and coronal cuts. Volumetric reconstruction and 3-dimensional imaging is possible with the newer equipment (helical CT scanning).

Advantages

It is widely available, and the newer scanners can perform the study very quickly. Volumetric and 3-dimensional reconstructions of the airway and other peripharyngeal structures are possible. The study is performed in the supine position.

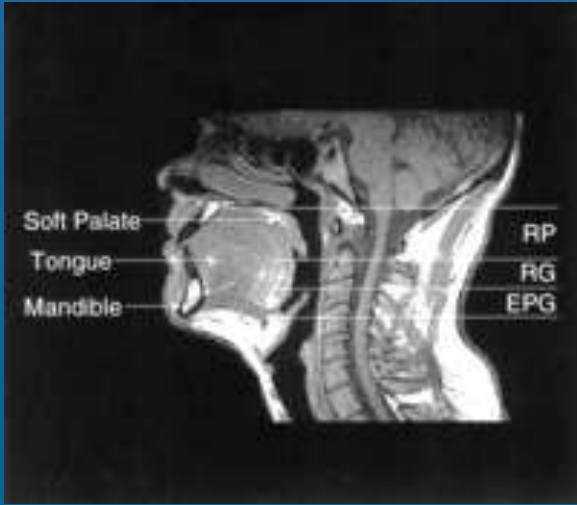
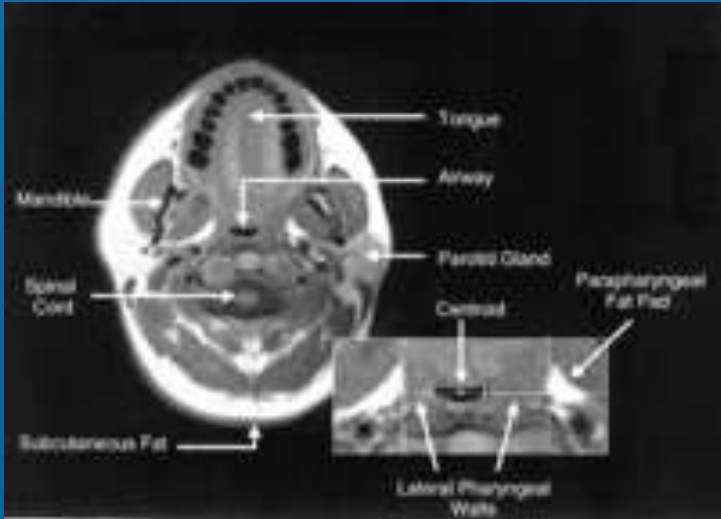
Disadvantages are radiation is involved. It is also relatively expensive. The actual image is in the axial plane, so performing a reconstruction is necessary to obtain a sagittal image

Because CT scan has high spatial resolution and provides tomographic images, it is often used to diagnose pharyngeal obstruction. However CT provides only axial Images and cannot image the entire pharyngeal airway in a single plane. It has been reported that on computed tomography examination reduced pharyngeal size correlated with increased sleep disordered breathing rates, and more severe nocturnal desaturations.

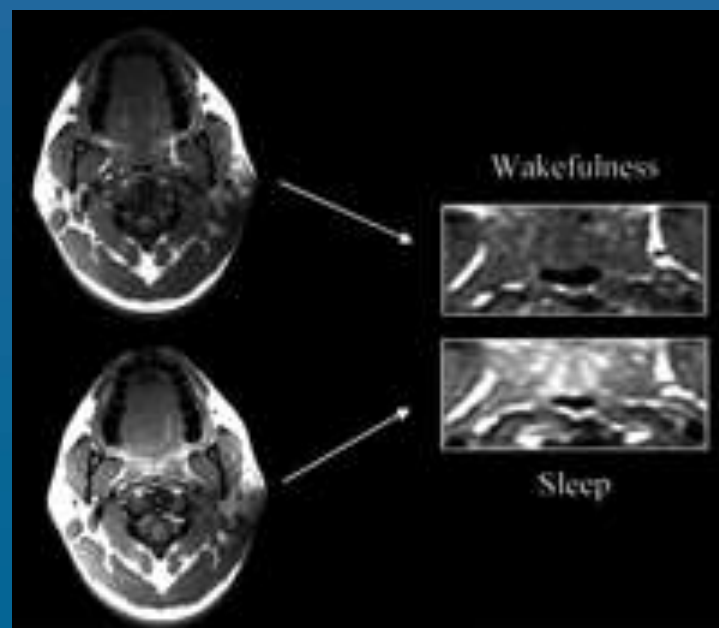


MRI

In 1992, a group in Japan reported the use of ultrafast MRI and found that it has the advantages of being noninvasive with high contrast resolution, allows scanning in multiple planes, allowing the whole airway to be visualized at one time. It is a non-invasive modality that allows examination of the entire pharynx in multiple planes and in a short time, with no radiation exposure as compared to CT. It provides good temporal and a high contrast resolution .A single excitation is used to obtain mid-sagittal and axial projections during transnasal shallow respiration at rest, simulation of snoring.



Using Muller's manoeuvre the motion of the tongue, soft palate, uvula and posterior pharyngeal surface can be visualised by obtaining 5-6 images per second. If the pharyngeal cavity is seen to be disappearing in trans-axial and sagittal planes, obstruction is diagnosed. Narrowing is said to be present if the pharyngeal cavity disappears only in one of the images and if there is more than 50% reduction in the pharyngeal space during sleep as compared to maximum area seen in wakeful state. Reduction in airspace up to 50% is considered normal. As the functional factor is different during sleep and wakefulness, imaging should be done in both states.



DISADVANTAGE

The studies done with MRI described only sites of airway obstruction, and did not measure, cross-sectional airway area, airway volume, or soft-tissue dimensions



VISUALISATION OF UPPERAIRWAY

Rigid bronchoscopy and laryngoscopy under general anesthesia may be necessary in children where the site of obstruction can not be determined by physical examination or radiographic studies.

Pharynx has been visualized with several techniques including cineradiography, fiberoptic bronchoscopy, acoustic reflectance. Anterior rhinomanometry has been found to detect sleep apnea in children with a nasal resistance of $0.59 \text{ Pa/cm}^3/\text{s}$ (Rizzi, 2002).



PHARYNGOMETER

UPPER AIRWAY RESISTANCE SYNDROME

This syndrome is characterized by repetitive arousals from sleep that probably result from increasing respiratory effort due to narrowing of the upper airway. In such cases, the only abnormality that appears on the polysomnogram is recurrent arousal. It is possible to measure an increase in the negative pressure exerted by the patient in an effort to breathe against increasing resistance as the airway narrows. Patients with upper airway resistance syndrome, therefore, constitute a group whose OSA could be easily missed by the polysomnogram. Patients with UARS have arousals during sleep related to the abnormally increased work of breathing and increased upper airway resistance, yet their respiratory disturbance index (RDI), may remain normal

TREATMENT OPTIONS

Selection of treatment(s) for individual OSA patients should be based upon balanced consideration of disease severity and site(s) of obstruction, subjective symptoms, risks of morbidity and mortality, and patient choice. Treatment effectiveness is variable and dependent on patient needs. It is believed that treatment must be evaluated over time for good patient outcome.

NONSPECIFIC THERAPY

These measures should be included in the treatment of all patients with OSA but should be used exclusively only in patients with very mild apnea whose main complaint is snoring.

1. losing weight.
2. should avoid the use of alcohol for 4-6 hours prior to bedtime, and sleeping pills.
3. Positional therapy can be used to treat patients whose OSA is related to body positioning during sleep.

There are several strategies which can help patients who have mild apnea only when lying on their back. One is to sew or attach a sock filled with tennis balls, length-wise down the back of their pajama top or nightshirt. This makes it uncomfortable for the sleeper to lie on their back, and they usually will move onto their side. Another technique is to use positional pillows to assist in sleeping on the side. Positional therapy has its limits, but it has been tried with success in some patients.

SPECIFIC THERAPY

The specific therapy for sleep apnea is tailored to the individual patient based on medical history, physical examination, and the results of polysomnography. Medications are generally not effective in the treatment of sleep apnea.

OXYGEN ADMINISTRATION

Oxygen is sometimes used in patients with central apnea caused by heart failure. It is not used to treat obstructive sleep apnea. Oxygen administration during sleep in some cases can paradoxically lead to significant worsening of the apnea. Supplemental oxygen may be helpful in patients who have frequent and severe desaturations. Oxygen at the correct flow rate when used in conjunction with nasal CPAP, however, in many cases corrects this problem. It is essential for the appropriate oxygen flow rate and appropriate nasal CPAP pressure to be determined while the patient is being monitored during nighttime sleep in a qualified sleep disorders center or apnea laboratory.

Physical or Mechanical Therapy

Patients with mild apnea have a wider variety of options, while those with moderate to severe apnea should be treated with nasal CPAP.

Positive Pressure Therapy

It has three forms: continuous positive airway pressure (CPAP), autotitration and bi-level positive airway pressure.

In 1981 Drs. Sullivan, Berthon-Jones, Issa and Eves from Australia published the first account of treating sleep apnea patients with continuous positive airway pressure (CPAP) thus initiating the most common and successful treatment, currently known, for this disorder.



MECHANISM OF CPAP

CPAP, is administered at bedtime through a nasal or facial mask held in place around the patient's head. The mask is connected to a small air compressor which sends air under pressure through the tube into the mask, where it imparts positive pressure to the upper airways. This essentially "splints" the upper airway open and keeps it from collapsing in the deeper stages of REM sleep.

Regardless of the mechanism used it is desirable to use the lowest possible pressure to eradicate the sleep apnea. It is necessary to titrate the pressure to each individual patient during a polysomnogram.

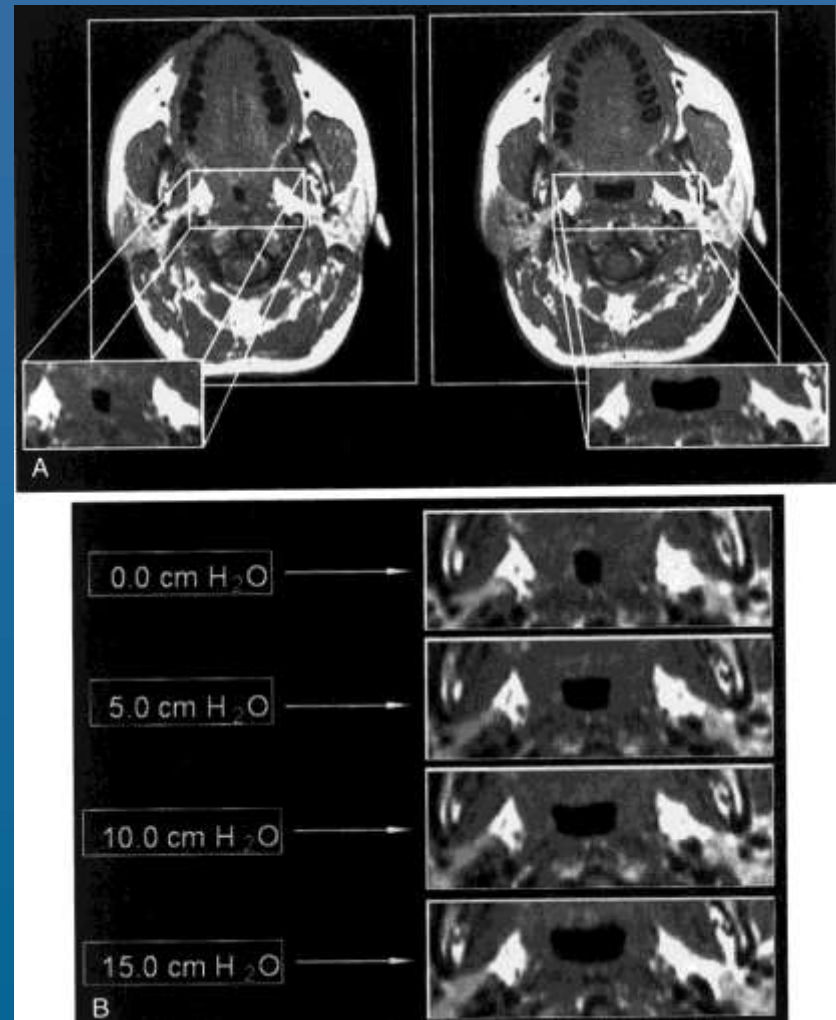


RESPIRONICS

Approximately 55 percent of patients who use CPAP do so on a nightly basis for more than four hours. It is the most commonly prescribed treatment for OSA.

CPAP decreases blood pressure, primarily in patients with severe OSA

(Becker, 2003; Pepperell, 2002; Faccenda, 2001). Evidence also suggests that CPAP may improve left ventricular ejection fraction in patients with congestive heart failure and OSA (Kaneko, 2003).



The Pros:

Tissues are prevented from collapsing during sleep, and apnea is effectively prevented without surgical intervention.

Daytime sleepiness improves or resolves

Heart function and hypertension improve

Quality of life improves

Survival rates may increase, according to some studies

Therapy improves obstructive sleep apnea, mixed apneas and some central apneas.

The Cons:

Many patients find the mask uncomfortable, claustrophobic or embarrassing.

Since CPAP is not a cure and must be used every night for life, non-compliant patients experience a full return of obstructive sleep apnea and related symptoms.

The sound of the machine may be disruptive.

Side effects may include:

Difficulty exhaling ,Inability to sleep, nasal congestion

sore eyes , sore or dry throat

Headaches,abdominal bloating,chest muscle discomfort
,nosebleed

mask-related problems such as rash, skin abrasions, and
conjunctivitis (from air leakage)

Autotitration devices are designed to provide the minimum necessary pressure at any given time and change that pressure as the needs of the patient change.

The AutoSet acts by monitoring the patient's inspiratory flow-time curve. Monitoring and responding to the flow-time curve, reduces the number of respiratory events and arousals improving sleep quality.

Bi-level positive airway pressure Because the air pressure required to prevent respiratory obstruction is typically less on expiration than on inspiration, bi-level positive airway pressure machines are designed to sense when the patient is inhaling and exhaling and to reduce the pressure to a preset level on exhalation. Bi-level positive airway pressure machines usually are used when the patient does not tolerate CPAP or when the patient has more than one respiratory disorder.

(Tan, L'Estrange EJO 2002) showed that the MAS may be a suitable alternative to nCPAP in patients with mild or moderate OSA and were well tolerated and preferred by the majority of subjects.

PHARMACOLOGICAL AGENTS

Thyroid hormone supplementation might lead to significant correction of the apnea if this is the sole problem. Control of blood sugar levels has, however, had at best a moderate effect in controlling the diagnosed obstructive sleep apnea.

Certain medications which increase respiratory drive are helpful in some patients.

PROGESTATIONAL AGENTS-Estrogen has shown to be used in central sleep apnea and obesity hypoventilation syndrome. not used in obstructive type.

OPIOD ANTAGONISTS AND NICOTINE-shown to improve oxygenation. not clinically useful as these are short acting and disrupt sleep cycle

ACETAZOLAMIDE-produces metabolic acidosis and stimulates ventilatory control centrally. very useful in periodic breathing and central sleep apnea. may be helpful in OSA

Tricyclic antidepressants -- Protriptyline has been used in people with mild apnea and snoring with mild success. It increases upper airway neuromuscular activity and decreases REM sleep. Protriptyline is not considered primary therapy for OSA. Consider use in a person with mild apnea who does not want CPAP or an oral appliance.

Increases synaptic concentration of serotonin and/or norepinephrine in CNS by inhibiting their reuptake by presynaptic neuronal membrane.

Modafinil -- May exert stimulant effects by decreasing GABA-mediated neurotransmission. Improves wakefulness in patients with excessive daytime hypersomnolence.

The use of modafinil can be recommended for patients who (1) regularly use CPAP (defined as >4 h/night for >5 night/wk), (2) have an ESS >10

The FDA recently approved the use of modafinil for the management of residual EDS in patients with OSA on nasal CPAP. (Kingshott, 2001; Pack, 2001; Schwartz, 2003).

Central nervous system stimulants

NON AMPHETAMINE -- Used for treatment of fatigue without interfering with normal sleep architecture. They promote wakefulness.

THEOPHYLLINE-Evidence exists to support its use in central sleep apnea. Also reduces obstructive events but causes severe sleep disruption

The search for a pharmacological agent to treat OSA has been disappointing though some patients respond to treatment.

SURGERY

Historically, surgical procedures for OSA treatment have included intranasal procedures, reduction glossectomies, uvulopalatopharyngoplasty procedures, and tracheostomy;

DISADVANTAGE

The pain and expense of the surgery and the relatively poor long-term success rate because the obstruction is often present at multiple levels.

USES

1. Surgery may be appropriate for patients who cannot comply with or are not appropriate candidates for conservative therapies or nCPAP alone. The type of surgery performed should be based upon the specific pathophysiology of a patient's condition.
2. Syndromic patients

Careful and thorough preoperative examination by radiography, imaging, and direct visualization is needed to identify the airway obstruction site(s) and to select the appropriate surgery.

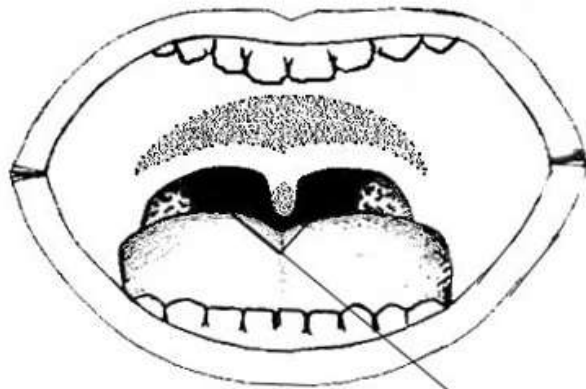
NASAL, SEPTAL AND ADENOID SURGERY

Weak or malpositioned cartilages around the nostrils can impede nasal breathing as will a droopy nasal tip or excessively narrow nostrils. The nasal turbinates may become chronically enlarged usually as a result of allergies. Reduction in the size of the turbinates will improve nasal air flow. If the septum is crooked, it may cause blockage of the nasal breathing passage. It is corrected by septoplasty.

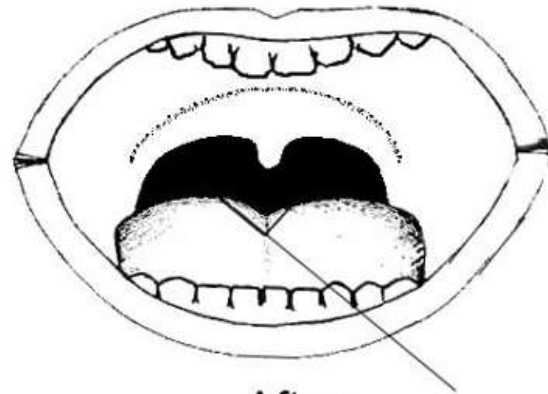
An enlarged adenoid may occasionally interfere with breathing. An adenoidectomy removes this excess tissue to allow for unrestricted airflow through the nasal passages and upper throat.

TONSILLECTOMY

The removal of redundant tissue by tonsillectomy increases the caliber of the pharynx thereby reducing blockage to breathing. Since the quality and quantity of tissue of the throat changes after tonsillectomy there can be a subtle alteration in voice quality. In a mature adult, pain following tonsillectomy can be unpleasant, but is reasonably well controlled with prescription medication.



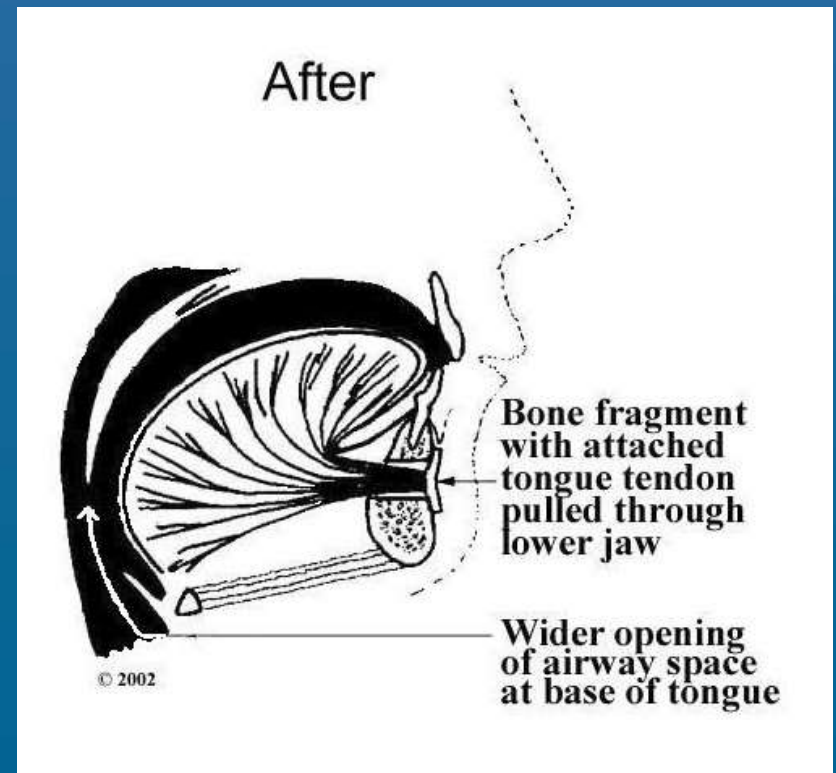
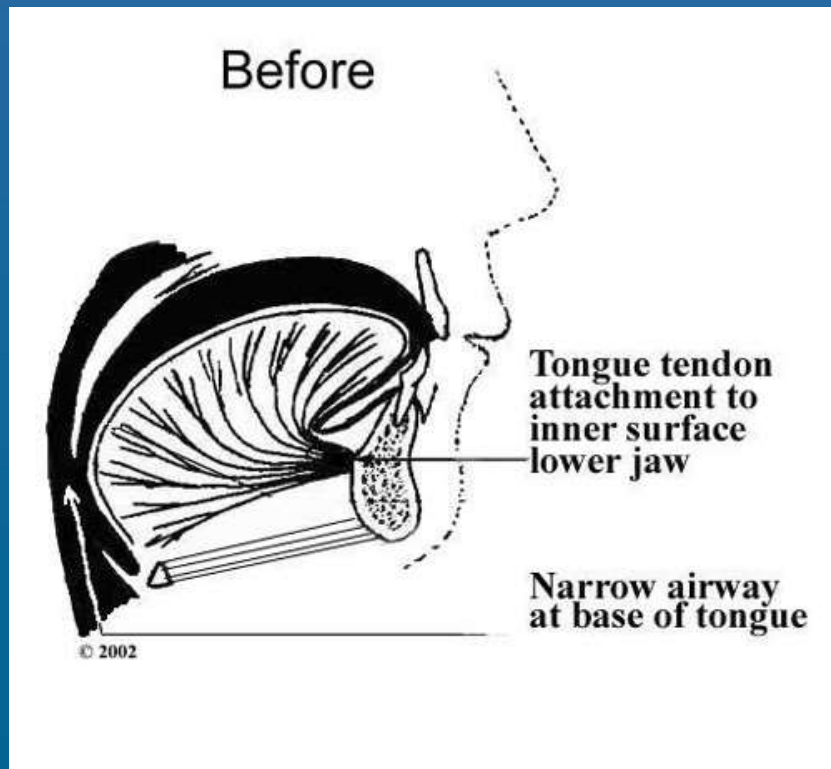
Before



After

GENIOGLOSSUS TONGUE ADVANCEMENT- The procedure is done through an incision below the gingiva in front of the mandibular anterior teeth. After creating a small rectangular bone window, the tendons that attach the tongue to the jaw are pulled forward on a small bone fragment. This produces a larger space between the back of the tongue and the throat thereby creating a wider airway.

There is minimal if any alteration in facial appearance. This operation is often performed in tandem with at least one other procedure such as the UPPP or hyoid suspension.



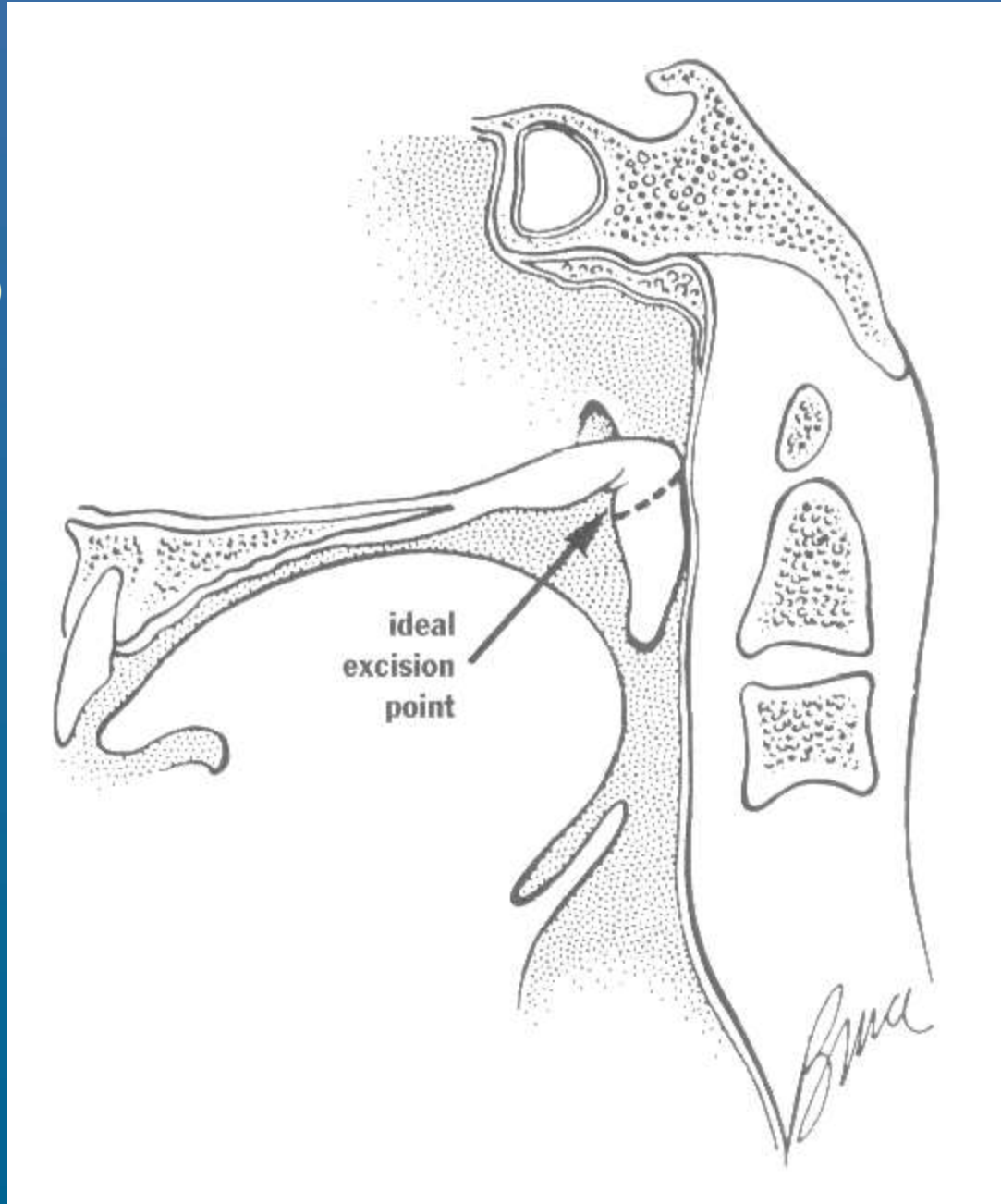
MIDLINE GLOSSECTOMY

The efficacy of midline glossectomy (MLG) following failed UPPP is relatively low and is variably affected by body weight and OSA severity; the long-term outcome after MLG is unknown



UVULOPALATOPHARYNGOPLASTY (UPPP)

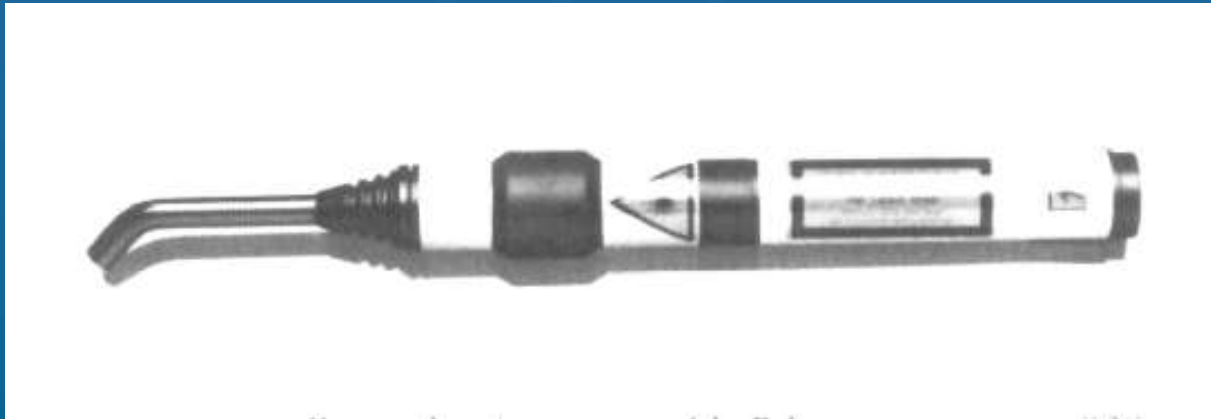
Younger patients and those who cannot tolerate CPAP may be candidates for surgical intervention to alleviate obstructive sleep apnea. Uvulopalatopharyngoplasty (UPPP) involves the removal of part of the soft palate, uvula and redundant peripharyngeal tissues,. This procedure is often effective in eliminating snoring; however, it is not necessarily curative for OSA, because areas of the airway other than the soft palate also collapse in most patients with this sleep Disorder . The success of this technique may range from 30 to 60 percent .



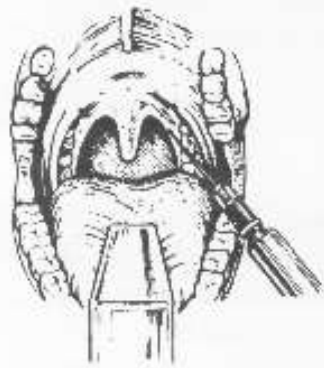
Adverse effects of UPPP include:

- Pain
- Bleeding
- Risk of infection
- Changes in voice frequency and possible leakage of liquids out of the nose.
- Rare instances of severe scarring of the palate could potentially worsen the OSA and make speech unusually non-nasal sounding.
- The failure rate increases when it is performed alone in the presence of retrolingual obstruction. In other words, many of the people who have UPPP will end up having to use CPAP anyway.
- UPPP generally requires three to five separate treatments, UPPP is an invasive procedure that typically requires general anesthesia and an overnight hospital stay.

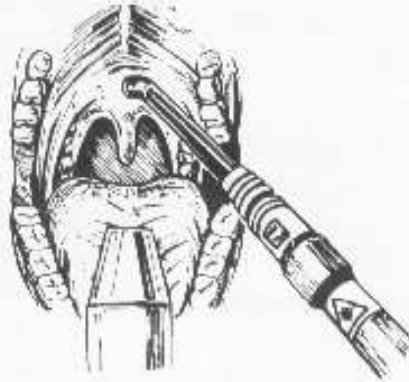
Laser-assisted uvulopalatoplasty (LAUP) Like UPPP, LAUP may decrease or eliminate snoring but not eliminate sleep apnea itself. To identify possible underlying sleep apnea, sleep studies are usually required before LAUP is performed. The gallium aluminum arsenide infrared P-laser (830 nm) has been used.



It is noninvasive and nondestructive to tissues, but it has an anti-inflammatory and hypoanalgesic effect, along with producing increased tissue healing in animal experiments. LAUP is about 85% effective in muting snoring and 65% effective in improving apnea..



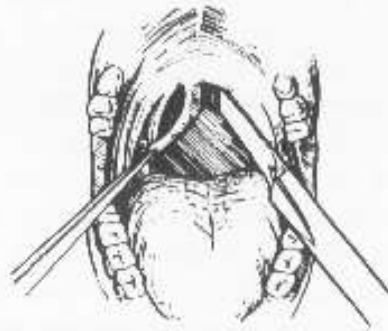
A Palate injection sites



B Cold laser application



C Initial vertical laser incisions



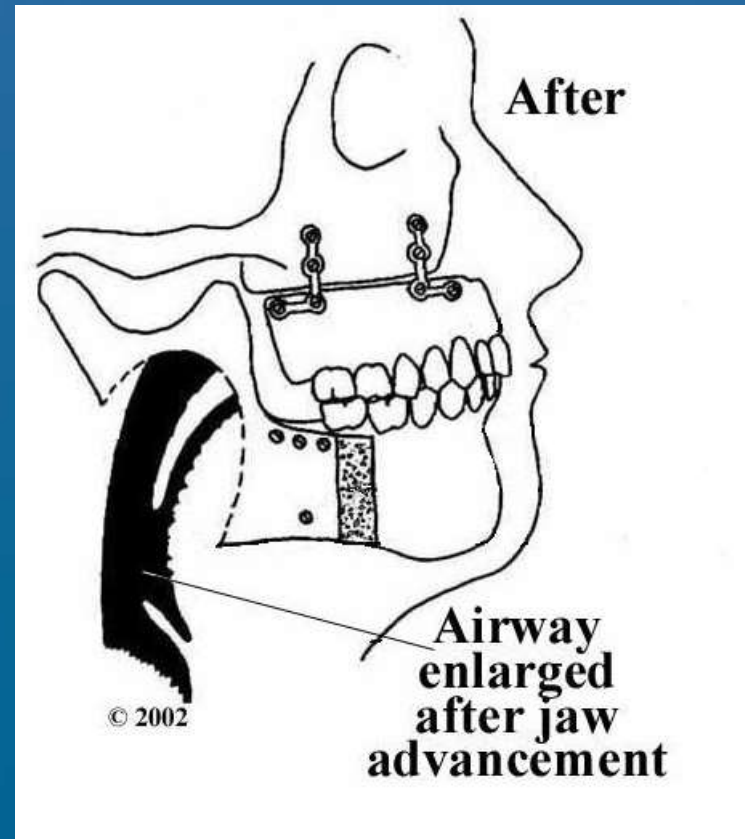
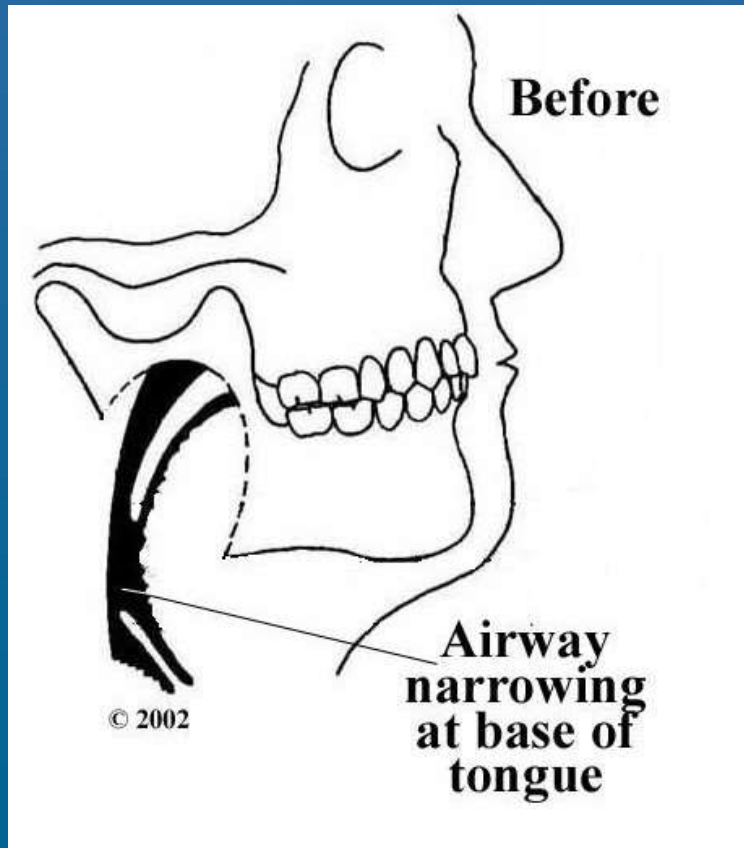
D Completing excision of uvula and soft palate



E Resection completed

MAXILLOMANDIBULAR ADVANCEMENT

A procedure whereby Lefort 1 osteotomy of the maxilla & sagittal split advancement of the mandible are performed. The concept is that as the bones are surgically advanced the soft tissues of the tongue and palate are also moved forward, again opening the upper airway. The usual movement is about a half an inch. Since the upper and lower teeth are moved the same amount, the bite would be similar before and after operation. .



This type of treatment is usually done if previous procedures have not completely improved the obstructive breathing episodes and the patient has persistent symptoms of daytime sleepiness and fatigue

ADVANTAGES

The MMA will always alter and often enhance appearance, but is not disfiguring. The procedure is technically involved with the potential for complications as in any surgical procedure, but most patients recover remarkably well from this surgery.

It has a 100% success rate

DISTRACTION OSTEOGENESIS

The bone segments are moved gradually to allow callus formation and adaptation of fibromuscular attachments. Once the desired length and shape is achieved, the hardware is left in place for an additional six weeks until the newly formed bone calcifies. Patient undergoing midface distraction are at a risk for developing velopharyngeal insufficiency. Speech evaluation is obtained preoperatively and after removal of device.

USES

1. Distraction osteogenesis is now a viable treatment option for adults and children with unilateral or bilateral mandibular and maxillary hypoplasia. It is a treatment option for widening an excessively narrow mandible.
2. Severe obstructive sleep apnea in patients who are morbidly obese.



RADIO FREQUENCY (RF) PROCEDURE OR SOMNOPLASTY is a surgical method which uses radiofrequency heating to create targeted coagulative submucosal lesions resulting in tissue volume

PROCEDURE

The radiofrequency treatment involves piercing the tongue, throat or soft palate with a special needle (electrode) connected to a radio frequency generator. The inner tissue is then heated to 158 to 176 degreesF, in a procedure that takes approximately half an hour. The inner tissues shrink, but the outer tissues, which may contain such things as taste buds, are left intact. During the following six to eight weeks the submerged wound undergoes healing, contraction and stiffening.



ADVANTAGES

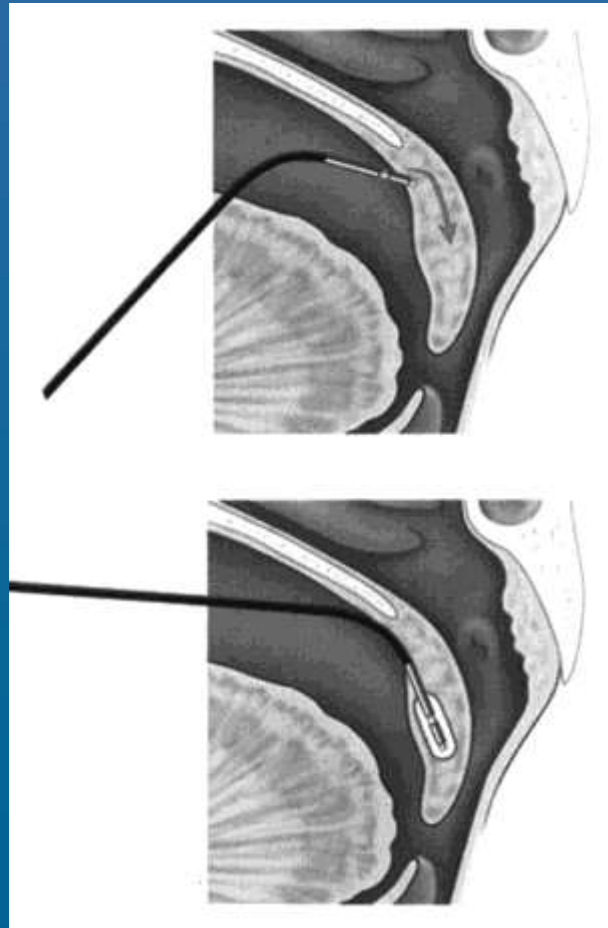
Somnoplasty is performed under local anesthesia in an outpatient setting. In contrast to conventional surgery, during somnoplasty we are able to protect the delicate surface of the tissue, control the delivery of energy and maintain a constant, low temperature, features that result in far less post-operative discomfort. While people undergoing traditional surgery can suffer significant pain and take narcotic medications for several weeks, individuals undergoing Somnoplasty usually experience swelling and some discomfort, and take pain medications for two to three days.

DISADVANTAGES

Need for multiple treatment sessions, overall limited clinical experience with the technique.

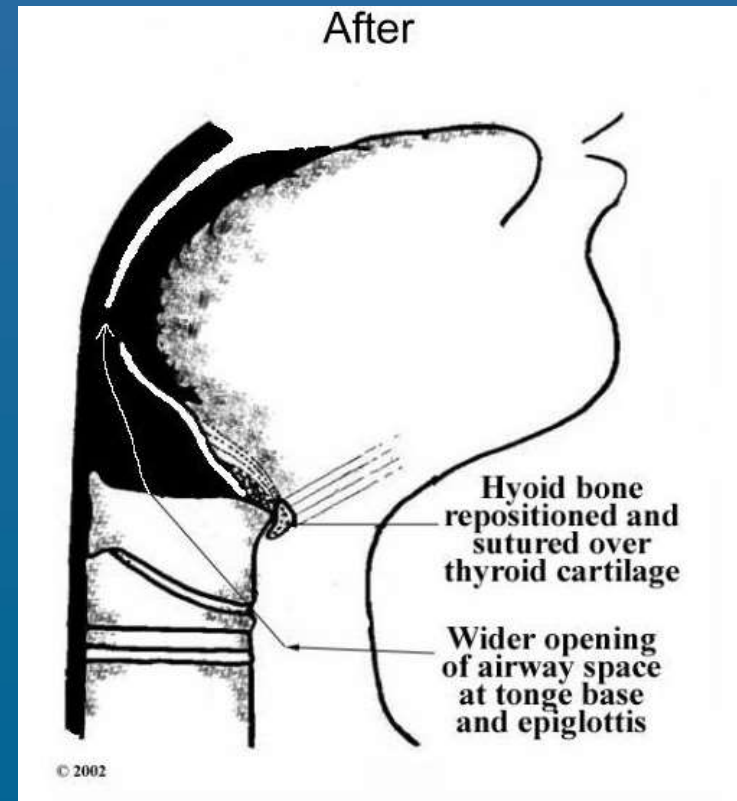
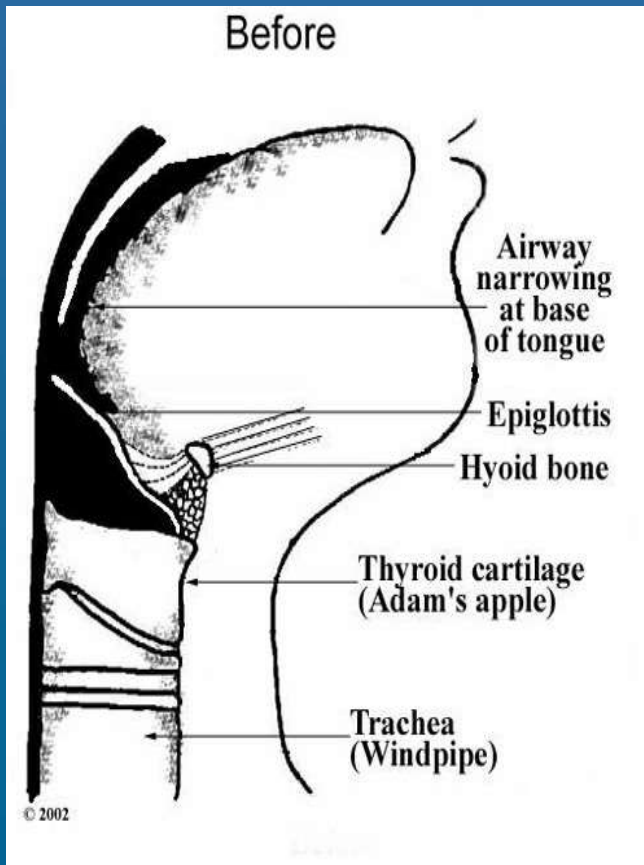
EFFECTIVENESS OF SOMNOPLASTY

Initial clinical results showed that Somnoplasty effectively treated OSA by shrinking the base of tongue - the most difficult source of obstruction to treat. . Clinical efficacy of the Somnoplasty treatment for turbinate hypertrophy published by Li, et. al. reported that 95% of the subjects studied had improvement in their nasal breathing at 8 weeks post procedure..



HYOID SUSPENSION

The operation advances the tongue base and epiglottis forward, thereby, opening the breathing passage at this level. The procedure is done through a small horizontal incision in a convenient skin crease in the upper neck. By detaching two tendons on the upper surface of the hyoid bone and some of the muscle on the lower surface, the hyoid can be advanced over the thyroid cartilage and secured in position.



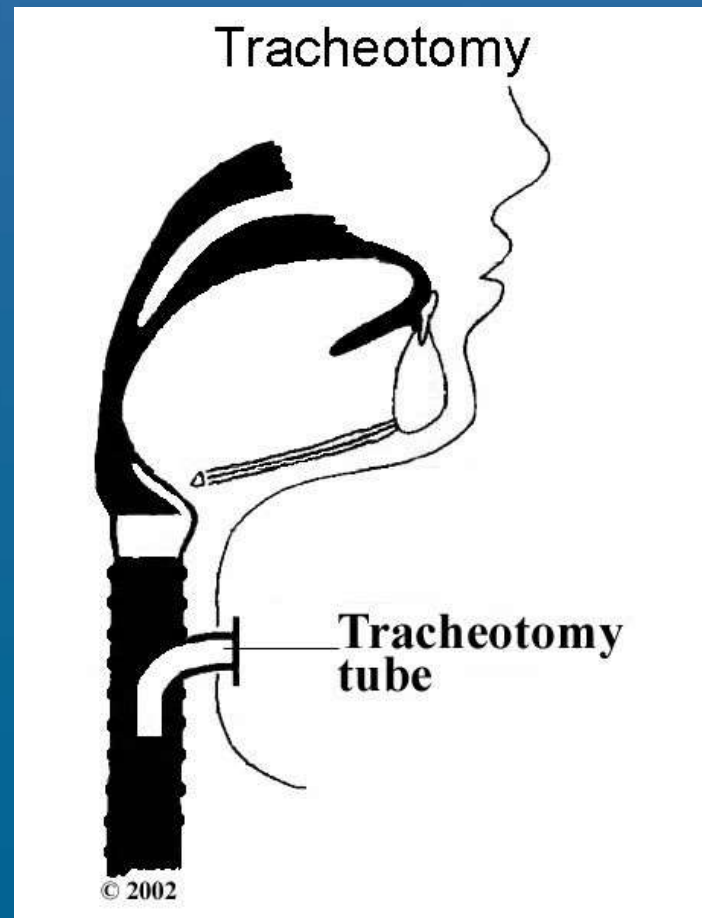
If the hyoid bone containing these muscles is pulled forward in front of the voice box, it can open the airway space behind the tongue.

ADVANTAGES

This is performed under local intravenous sedation or general anesthesia, and requires a one or two day hospital stay. Since the vocal cords are not manipulated, the voice should remain unimpaired.

TRACHEOSTOMY

A Tracheotomy is one of the oldest, most shunned, and least understood procedures for OSA. The concept with this procedure is that any area of blockage to breathing, from the nose to the voice-box, is bypassed by a hole placed into the windpipe. The tracheotomy tube must be kept exquisitely clean; otherwise, painful infections will occur, or the tube and/or windpipe could become blocked with secretions.



USES

when OSA is severe and CPAP is not tolerated or ineffective or cardio-pulmonary failure has developed then a tracheotomy may be the initial treatment of choice. A month or two later a sequence of procedures can be initiated as indicated.. If the sleep study showed resolution of the OSA then formal plans could be made to remove the tracheotomy tube and allow the stoma to be closed. Few patients (eg, those who have severe heart failure or severe pulmonary disease, who cannot tolerate CPAP, and for whom other measures failed) require tracheostomy.

ORAL APPLIANCES

Originally, MAAs were derived from an orthodontic functional appliance, the Esmarch appliance as proposed by Meyer-Ewert and Brosik (1987), which has been variously modified with the aim of increased effectiveness and patient compliance (Eckhart, 1998; Lowe, 2000) for intra-oral use (US Food and Drug Administration, 1999).. Of the more than 50 appliances available on the market today, fewer than 15 are accepted by the FDA for the treatment of obstructive sleep apnea. All of the accepted appliances are custom-made in a laboratory and cannot be fitted in a single appointment.

There are main appliance groups: tongue repositioning devices, such as the tongue retaining device, mandibular advancement devices which work by holding the lower jaw and the tongue forward during sleep and devices designed to lift the soft palate or reposition the uvula .Uvula lifters are not in use now due to discomfort.

Tongue Retaining Devices

The Tongue Retaining Device was first developed by a physician in 1979. It is a bubble shaped device made of soft polyvinyl. The patient's teeth rest in custom fitted grooves which are extended to form a 'bubble' that sticks out from between the lips. The patient positions his teeth in the grooves, sticks his tongue forward into the bubble until suction grabs and hold the tongue in place. Positioning the tongue forward may eliminate any obstruction caused by the base of the tongue.



USES OF TRD

Found to be most useful in patients with very large tongues, poor dental health, no teeth, chronic joint pain, or if their sleep apnea is worse when lying on their backs than when they lie on their sides at night.

CANNOT BE USED IN

People who are tongue-tied, so overweight that they are more than 50 percent above their ideal body weight, grind their teeth at night, or have chronically stuffy nose .Patients complain most often about irritation on the tip of their tongue (which can be painful, or cause irritation to spicy and salty foods). Patients also require practice in swallowing with the appliance in-place, because the tongue cannot move in its normal pattern. This appliance also forces nasal breathing and can be difficult to use if the patient has a stuffy nose or allergies.



One form of this appliance comes with "breathing tubes" on either side of the front bubble, but no research has been done using this form of the appliance.

Appliances / Oral Airway Dilator Designs

:

1. The Silencer System: This appliance incorporates the Halstrom Hinge Titanium Precision Attachment at the incisor level, allowing sequential 2 mm advancements up to 8mm, lateral movement 6 mm, 3 mm bilaterally, and vertical pin height replacements. A flat posterior bite plane is provided for the biting surfaces. Unlike the previous four appliances, this appliance cannot be adjusted by the patient, but must be adjusted in the dental office. It is made of elastomeric plastic and is the only appliance that allows adjustment in not only a front to back position, but in an 'open and close' position. Because it includes a very expensive titanium metal hinge device, this appliance is one of the most expensive available



2. The Klearway oral appliance, which utilizes a maxillary orthodontic expander to sequentially move the mandible forward. Klearway is a fully-adjustable oral appliance used for the treatment of snoring and mild to moderate Obstructive Sleep Apnea. Fabricated of thermoactive acrylic, Klearway™ becomes pliable for easy insertion and conforms securely to the dentition for an excellent fit while significantly decreasing soft tissue and tooth discomfort. Small increments (25 mm) of forward lower jaw advancement are initiated by the patient under the direction of a dentist and this helps avoid rapid jaw movements that can cause significant patient discomfort. Once warmed under hot water and inserted, the acrylic resin hardens as it cools to body temperature and firmly affixes itself to both arches. Lateral and vertical jaw movement is permitted which enables the patient to yawn, swallow, and drink water without dislodging the appliance.



3. The PM Positioner, which links upper and lower splints with bilateral orthodontic expanders, has attachment connectors on both lateral sides. This appliance is made of a thermoplastic material which must be heated in hot tap water every night before it is placed in the mouth. The adjustment hardware is rigidly bound on the buccal side of the molar teeth and allows no movement of the bottom jaw while the appliance is worn.



4. The TAP-Thornton Adjustable Positioner, which allows for progressive $\frac{1}{4}$ mm advancements of the jaw via an anterior screw mechanism at the labial aspect of the upper splint. This is an appliance which has a separate section for the mandible and maxilla. Each portion of the appliance is placed in the mouth separately and then the patient sticks out his/her chin until the 'hook and bar' hardware can be connected. The hardware is located at the tip of the tongue, and may take some getting used to. The adjustment knob sticks out through the lips and is visible when sleeping. This appliance is easily retained by tooth grinders, even those who have worn away much of their tooth structure.



5. Modified Herbst: This appliance design links upper and lower splints with a piston-post and sleeve adjustable telescopic mechanism on each side. It prevents side-to-side motion, but since the mandible is held closed with small orthodontic rubber bands, opening the jaws is fairly easy. Patients who severely grind their teeth at night can crack this appliance.



6. The EMA Elastic Mandibular Advancement : This appliance design uses specially designed, patented elastic bands to reach the desired position with considerable freedom of movement. The E.M.A. is the thinnest and least bulky of all the appliances. It is similar to clear acrylic orthodontic retainers, and moves the jaw forward in fairly significant steps, and can be difficult to tolerate



OPAP : '*Oral Pressure Appliance*'

It is a "combination" therapy which combines a nonadjustable MRD with continuous positive airway pressure (nCPAP). Instead of using nasal nCPAP, which delivers air pressure through a mask over the nose or the nose and mouth, the air pressure is delivered through a small conduit that fits across the roof of the patients mouth. Thus, the more effective nCPAP can be used by patient without the need to wear a nasal mask, have elastic straps around the head, or sleep on one's back.

Pressures necessary to control snoring and obstructive sleep apnea are much lower when delivered through OPAP than when using nasal delivery.



MRD Indications:

mild to moderate OSA and patients who do not exceed 125%-150% of their ideal body weight.

UARS with snoring and mild OSA

Retrognathia

Failed other modalities of treatment especially effective if UPPP did not bring down RDI to an acceptable level

Pt. refuses surgery

Pts are poor surgical risks, medically compromised, or elderly

Pts are non-compliant with CPAP

Pts are mouth breathers or nose breathers

As a diagnostic tool prior to maxillo-facial surgery

MRD contraindications:

Severe periodontal disease

Existing temporomandibular joint disease (arthritis, etc.)

Painful masseter muscles

Incomplete dentition which compromises retention of the appliance

Atrophic edentulous ridges as evidenced by poor denture retention

Severe hypoxemia

Severe OSA

Growing children

Protrusive range of mandible < 7 mm

Ability to open interincisally 30 + mm

Unmotivated patients

Morbidly obese NC <20" or weight over 300 lb. for men. NC over 17" for women.

(Lowe) obese pts are less compliant with OA use (patients are found not to respond well to OA therapy if more than 150% ideal body weight because obesity limits pharyngeal airspace, increasing obstruction)

Central sleep apnea

MECHANISM AND SUCCESS

MAAs enlarge and stabilize the oro- and hypo-pharyngeal airway space by advancing the mandible, and stretching the attached soft tissue, and in particular the tongue (American Sleep Disorders Association, 1995; Lavigne *et al.*, 1999). A tooth-borne device and a modified activator have been reported to reduce snoring and to improve the incidence of OSA (Clark *et al.*, 1993; Rose *et al.*, 2000).

In a prospective computerized tomographic study, Gale *et al.* (2000) showed that there is a wide and unpredictable intra-individual variation in the response to mandibular advancement. When comparing differently designed oral appliances in various patient groups, the results may reflect differences between the groups, e.g. due to intra-oral and pharyngeal anatomy, rather than between appliances.

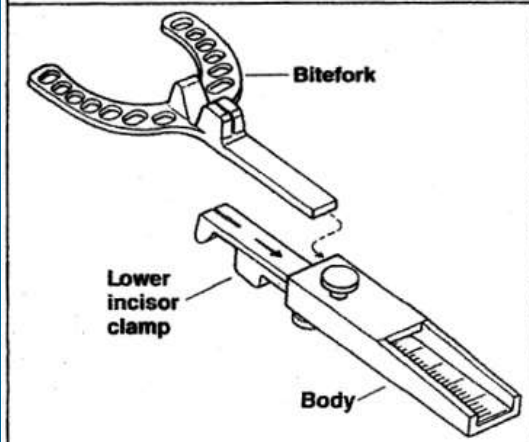
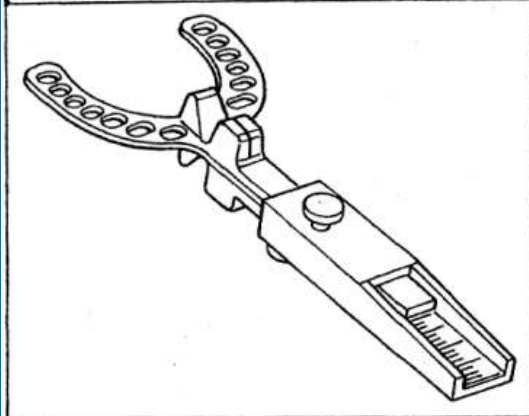
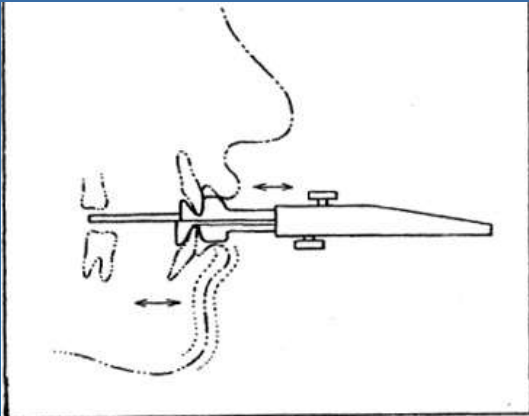
With treatment success based on RDI reduction alone, improvements of 66 per cent (Karwetzky activator) and 53 per cent (Silencor) were measured; these success rates are thus similar to those of other, comparable designed appliances (Schmidt-Nowara *et al.*, 1995; Clark *et al.*, 1996; Liu *et al.*, 2000). This difference in treatment success might be due in part to the design characteristics of the appliances, since the materials and the rate of retention differed.

FABRICATION OF APPLIANCE

It is constructed of a temperature-sensitive acrylic resin that is slightly soft at body temperature and very compliant at higher temperatures . This decreases tooth discomfort but also considerably increases retention. The adjustable mandibular advancement appliance also permits lateral and vertical jaw movement during sleep to reduce the risk of temporomanibular joint and jaw muscle discomfort. Full-tooth surface coverage reduces the possibility of any occlusal change.



70% MAXIMUM MANDIBULAR PROTRUSION



An initial bite registration was taken at two thirds of the maximum protrusive position. The George gauge overestimated the maximum range of protrusion compared with the ruler measurements. (Anette M. C. Fransson Tegelberg EJO2003)

Minimum vertical separation between maxillary and mandibular incisors was obtained. An adjustment period followed the insertion of the appliance during which the advancement was continued until relief or maximum reduction of snoring and reported apnea.

ADVANTAGES OF ORAL APPLIANCES

The main advantages of oral devices are the relative simplicity of the treatment, the reversibility, and the cost effectiveness.

DISADVANTAGES

Complications of MRD use can include mobile teeth, joint pain, muscle aches, tissue sores, inability to touch the back teeth together when the appliance is first removed in the morning, permanent tooth movement, and excessive salivation.

Studies have shown that long-term use of appliances which moved the jaw forward result in permanent tooth repositioning in as many as 20 percent of patients (Panula AOO 2000). Hence MAA should be fabricated as thin as possible to promote more horizontal protrusion and prevent counterclockwise rotation.

Patients must be aware that MRD therapy carries with it a 10 percent risk that the patient's disease will get worse. This appears to be unique to MRD therapy, and may require the patient to have a follow-up sleep study even if symptoms are relieved.

LITERATURE REVIEW OF MRD

Airway change:

PAS (Posterior Air Space) did not always increase on cephalometric studies with the MRD device in place. Rick Schwab's work shows lateral increase of up to 25% retroglossally and 16% retropalately.

Awake Fiberoptic videoendoscopy showed no alteration in hypopharynx or oropharynx, but a significant increase in x-sect. of velopharynx. MRI evaluation with MRD in place showed 32% total increase in volume with the largest improvement in the airway behind the mid-soft palate and uvula/ nasopharynx area

Decrease in MP/H shown by multiple appliances (Bonham, Eveloff)

Sleep change:

A 39% relative decrease in stage 1 sleep (Clark / Herbst)

Increases in stage 2, 3, 4 and REM sleep (Clark / Herbst)

REM sleep increased 50%.

The average total sleep time increased by 23 minutes Total sleep time was unchanged (Menn) Arousal Index decreased significantly

Sleep efficiency improved from 80% to 86% (Menn)

Apnea change:

70% of pts show a 50% decrease in RDI (Schmidt-Nowara, et al, ASDA Review)

56% returned to normal breathing (RDI below 10/hr)

Review 1995: AI decreased 54.3% RDI decreased 53.8%

Arterial oxygen saturation increased in 75% of the patients and O2 nadir from 78% to 86% (Menn)

The initial rate of complete airway obstruction decreased 10.1 events/hour and partial airway obstructions decreased by 9.07 events/hour.

MRD devices showed a reduction of apneic events in patients with OSA as well as central apnea. There was no change in the amount of time spent in mixed apnea. Yoshida reported a slight increase in central apneas and a decrease in mixed and obstructive apneas .Some studies claim 60% success rate (RDI <10) in moderate and severe OSA

Symptom change:

Patients reported a decrease in snoring, increased alertness and some reduction in daytime sleepiness (subjectively).

Snoring reduced >50% in 87% of pts. (Schmidt-Nowara review)

Appliances become more effective with time, possibly due to the resolution of edema. (Lowe)

Anatomic Repositioning:

Opening of the airway, especially in the lateral aspects of the PAS (25% hypoglossally, 16% retro palatally) (Ferguson or Schwab). Opens all 3 areas of pharynx (Evaloff) Statistical in velopharyngeal area only (Lowe)

The tongue advances .Tongue is placed more superiorly and the dorsal aspect of the tongue becomes narrower and moves superiorly , The hyoid moves more anteriorly (Lowe).

Thinning of the lateral walls of the pharynx occur as the tension increases on the soft palate

Clockwise rotation of the mandible and passive opening of the vertical dimension activates the genioglossus muscle effecting changes in the shape of the tongue. Lowe's animal studies demonstrated that the increased gg muscle activity remains relatively constant as long as the OA is in place.

A stable anterior position of the mandible and tongue which prevents posterior relapse of the mandible and tongue during sleep.

Mandibular protrusion and concomitant tongue repositioning might modify the position and function of the soft palate by virtue of its attachment to the base of the tongue- as seen in two studies where PNS-P (length of the soft palate) was reduced with the appliance in place. (Lowe, Schmidt-Nowara)

Hyoid moves anteriorly in successful cases

CT and MRI imaging confirm the expectation that MRDs designed according to currently accepted treatment protocols cause the mandibular condyle to translate a significant distance out of the glenoid fossa, even as far as the articular eminence. (L. Barsh)

Stabilization:

Mandible is stabilized in position

An oral airway appliance may alter pressures in the oropharynx so as to reduce narrowing and collapse during inspiration.

Prevention of wide mandibular opening prevents the mandible from rotating backwards and the base of the tongue obstructing the airway.(L'Estrange)
(Yoshida)

Prevention of opening the mandible inactivates the 'anti-tongue biting' reflex which causes the tongue to retract. Passive or active opening activates afferents in TMJ that reflexively inhibit the genioglossus muscle, making the tongue more vulnerable to negative pressure in the airway.

Increased Muscle Tone:

Increase gg muscle activity

Increased tonicity of the genioglossus muscle related to mandibular protrusion and increase in vertical dimension . This may counteract the loss of muscle tone experienced during stage 3&4 nonREM and REM sleep. (Lowe, animal studies)

OA may stimulate receptors in the UA to increase airway tone. (Stollin & George)

DENTAL EFFECTS

Significant retroclination of the maxillary incisors and proclination of the mandibular incisors

were accompanied by reductions in maxillary arch length, overbite and overjet. The SNA, ANB angles, ANS–PNS length and face height increased, and the mandibular first molars and the maxillary first premolars significantly over-erupted. The appliance used produced small, changes in the occlusion that tended to occur after 24 months wear. It is postulated that the changes in overbite might be lessened by keeping the bite opening to a minimum.(Christopher Robertson, Peter Herbison EJO2003)

Minor dental changes might be an acceptable side effect, if associated with significant treatment efficacy. In cases of unacceptable, progressive occlusal alterations, the indication for therapy with an OA has to be re-evaluated, and, in severe cases, therapy might have to be changed to CPAP.



Good Response Group

Forward maxilla
Smaller oropharynx
Less erupted maxillary molars
Smaller incisor overjet
Longer pharynx and/or
smaller soft palate
Lower BMI
Younger



Poor Response Group

Retruded maxilla
Larger oropharynx
Overerupted maxillary molars
Larger incisor overjet
Shorter pharynx and/or
larger soft palate
Higher BMI
Older

Fig 4. Schematic summary of cephalometric and demographic characteristics of OSA patients with good and poor responses to adjustable mandibular advancement appliance based on stepwise regression equation.

Predictors of Success:

One cannot predict the potential success of OA treatment based on anatomic consideration alone (Lowe). Success has been variously defined by various investigators, but OA researchers now tend to use the same criteria as CPAP researchers: i.e.. the RDI must drop by 50% from the baseline RDI AND end below 10. (Some accept 15 as a therapeutic RDI)

Less successful if soft palate length is over 48 mm, Responders avg. soft pal. 44mm, non-responders avg. 50 mm (Bonham)

OA therapy is more successful if mandibular plane angle is normal and the lower face height is smaller. (Bonham)

Baseline MP-H smaller (Eveloff found the MP-H base in responders was 23degrees and 1 mm vs. 28.6 degrees and 1.5 mm)

Appliance shortens soft palate (Evaloff) found baseline PNS-P didn't vary between responders and non responders, but with the appliance in place, responders had a shortened PNS-P of 41mm vs. 47mm.)

Responders have a lower BMI vs. non-responders (Lowe) OA responders, in 1 study, had baseline RDI <10, partial responders RDI < 20 NB: There is no placebo effect with an oral appliance. The mandible MUST be advanced for a positive effect with an MRD. (Hans, et al)

BMI and cephs are not predictive of success (Menn)

CONCLUSION

Sleep-breathing disorders are potentially life threatening; therefore, the diagnosis and treatment of these diseases are the domain of the medical profession. The prevailing opinion is that patients should be treated only with a referral by a physician. As orthodontists we have a significant role in the diagnosis of sleep apnea and the oral appliance therapy to improve the quality of life to the apneic patients.