



## **Prosthodontic Management of Obstructive Sleep Apnea**

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### **ABSTRACT**

*As evolution is in progress, our modern society is experiencing inferior quality of sleep and sleep lasting for short duration and this has resulted in many unfavourable outcomes on general wellbeing. Obstructive sleep apnea is irregular breathing which occurs when a person falls asleep. An individual's breathing often ceases multiple times during sleep. Number of disturbed breathing events is counted per hour in Apnea-Hypopnea index (AHI). Score of 5 or greater than 5 is indicative of OSA. Score of 5 can be concurrent with symptoms which include waking hour's sleepiness, lethargy, and impaired perception whereas a score of 15 or more, regardless of concurrent ailments is confirmatory for OSA.*

**Key Words:** Obstructive Sleep Apnea, Corpulent, Hypopnea, Apnea, Mandibular advancement Appliances.

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### **INTRODUCTION**

Sleep is a physiologic phenomenon of brain and body, in which consciousness is altered, an individual experiences partially inhibitory response to sensory activation associated with altered muscle activity and relatively all voluntary muscles are inhibited at the time of REM stage abbreviated for sleep Rapid Eye Movement phase [1], along with overall decreased response [2]. Wakefulness and sleep can be differentiated by a lessened response in sleep to stimulus, but greater than either instate of coma or derangement of consciousness, as reflected by altered active areas of brain.

Sleep progresses in recurring episodes of REM stage and NON-REM stage. REM is abbreviated form of "rapid eye movement", this stage can be recognized as virtual paralysis of the body and state of dream. As sleep progresses body's systems enter anabolic state that helps to rehabilitate various systems of body such as immune, skeletal, and muscular systems and nervous [3]. They are a vital process that aids the body in regulating temperament, ability to recall, and function related to perception, and performing a significant role in regulating the function and maintaining the circadian rhythm of the endocrine and immune systems [4]. The hormone melatonin regulate the sleep-cycle and maintain the circadian rhythm. Humans may suffer from multifarious sleep derangement among which the most prevalent respiratory disorder associated with obstruction in airway is sleep is Obstructive sleep Apnea [5].

### **OBSTRUCTIVE SLEEP APNEA**

OSA is acronym for Obstructive sleep apnea and is described as pause in breathing while asleep. Cessation of breathing is attributable to complete or incomplete obstruction in upper airway, causing alteration in physiologic progression of sleep. Apneas occur when the muscles of Upper respiratory tract participating in breathing loses tonicity during sleep, resulting in collapse of the upper airway and completely stop the inflow of oxygen [6]. Apnea can be categorized as Central sleep Apnea, Obstructive sleep apnea and complex sleep apnea. Blood oxygen saturation level drops significantly and this causes the individual to have breaks during sleep and individual gasp for air by coming out of deep sleep and breathing is resumed. As count of these episodes increases per hour over a period individual lifestyle gets affected, and this requires further treatment. Sleep apnea usually is diagnosed by conducting sleep study at nighttime in sleep lab, because the period of wakefulness during sleep are of short duration and individual doesn't recall experiencing them at night, though fatigue in the morning is a common experience. The terms obstructive sleep apnea syndrome (OSAS) or obstructive sleep apnea-hypopnea

syndrome (OSAHS) is assigned to Obstructive sleep apnea in which symptoms are observed during the wakeful hours (e.g., excessive daylight sleepiness, decreased perception to environment).

## HISTORY

Pickwick an syndrome is commonly addressed as obesity hypoventilation syndrome (OHS). In this syndrome blood oxygen saturation is affected and has excess carbon dioxide level. Sir William Osler in the year 1918 composed the term "Pickwickian address to corpulent, hypersomnolence patients. Dr Burwell and colleagues in the year 1956 described the association between corpulence, soporiferous, and increased breakdown in respiratory and cardiac system and proposed the nomenclature ("Pickwickian Syndrome") [7]. Dr. Gastault and colleagues, French group of investigators, in the year 1965 highlighted significant association that "Pickwickian" patients had repetitive apnea episodes during sleep. This answered collapse of upper Respiratory tract occurring in obstructive sleep apnea while asleep.

## CLASSIFICATION

The International Classification of Sleep Disorders (ICSD-3), has classified Sleep hindrance into two Divisions, namely Adult OSA and Pediatric OSA [8]. Sleep-Related Breathing Disorders includes Apnea. Obstructive Sleep Apnea is associated with periods of reduced or abeyance in breathing attributable to obstruction in upper air passage. Central sleep apnea exhibit absence of effort to breathe. Specificity of the diaphragmatic activity is used to determine the respiratory effort whether the inspiratory attempt is continuous or escalated throughout the period of missing airflow.

Obstructive Sleep Apnea-Hypopnea expresses combination of apneas and hypopnea episode, Obstructive Sleep Apnea-Hypopnea Syndrome [9] is applied when excessive sleep is often experienced in daytime by an individual along with night time episodes of Hypopnea and Apnea.

Diagnostic symptoms of obstructive sleep apnea must fulfill the requirement of one or all three below mentioned observation such as

- (1) Snorting
- (2) Oropharyngeal and nasopharyngeal flow is diminished
- (3) thoraco-abdominal paradoxical breathing during the episode [10].

The Apnea-Hypopnea Index (AHI) quantifies sleep apnea. The index is calculated as summation of numeral of episodes of apnea along with the number of hypopne as that happen during an hour. The duration of each is at least 10 sec (table 1).

**Table 1. Apnea-Hypopnea Index**

AHI	Rating
<5	Normal (no Sleep Apnea)
5-15	Mild Sleep Apnea
15-30	Moderate Sleep Apnea
>30	Severe Sleep Apnea

## ETIOLOGY

Corpulence is major contributor in developing OSA. The concurrence of OSA and obesity ranges between 55% to 100% and individual's exhibit escalated BMI. Corpulent individual exhibit greater score on AHI and touch lower base on pulse oximetry performed at night [11]. Individuals with craniofacial anomalies such as small jaw, dilated palatine tonsils, enlarged uvula, palate which is high arch, deviation in position of nasal septum, elongated facial height in anterior region, steeper and smaller cranial base anteriorly, inferior displacement of hyoid bone associated with longer H-MP distance [12], macroglossia, elongated soft palate, and narrow air channel space posteriorly contributes to development of OSA.

## RISK FACTORS FOR OBSTRUCTIVE SLEEP APNEA

**Age-** 29: individual in age group above 65' have exhibited greater prevalence. As an individual age advances the muscles of throat begin to lose tone. As throat muscles lose definition, weakness causes diminished patency of the airways during sleep.

**Gender-** 30: OSA percentage is higher in Males as compared with female. Postmenopausal women as compared with premenopausal women exhibit higher percentage of OSA.

Neuromuscular Disorder 31-In Postpolio syndrome the upper airway is affected due to inadequate neuromuscular control.

Drugs 32-upper airway muscles are relaxed, and the brains excitability is interfered by intake of drugs. e.g Alcohol, Sedative, centrally acting anti-inflammatory drugs.

Cerebrovascular Lesions-32- Reported Episodes of silent cerebrovascular lesion is higher in individual with AHI score of 15 and more rather than individual with score of 5.

Craniocervical Angle -33-Apneic individual exhibit a larger C4C2SN due to extended and forward head position in comparison with non-apneic subjects.

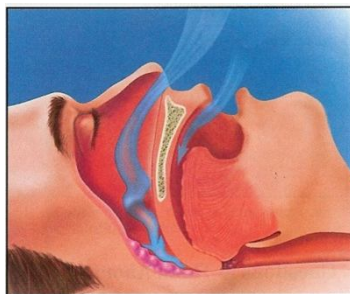
**Influence of Tooth Loss on Obstructive Sleep Apnea:** Edentulous individuals exhibit higher incidence of OSA. The changes observed in the oral cavity are as follows

- Vertical dimension of occlusion is Decreased
- Mandible is positioned Posteriorly
- Hyoid bone is positioned posteriorly and inferiorly
- Impaired function of oropharyngeal musculature due to reduced tone in soft palate and pharynx, macroglossia results in impaired function of oropharynx [13-15].

**ALCOHOL CONSUMPTION AND SMOKING:** Smokers exhibit higher association of snoring and sleep-disordered breathing (SDB). The cigarette smoke initiates inflammation of upper airway and this continuous inflammation over a period results in damage to the tissues of the upper airway resulting in loss of patency followed by pause of breathing during sleep. Alcohol reduces the tonicity upper air channel muscles mainly dilator muscles thereby increasing resistance of air channel precipitating OSA in prone individuals [16].

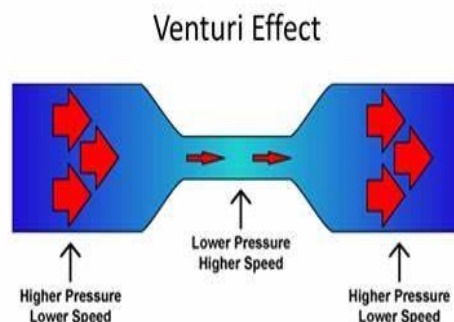
### PATHOPHYSIOLOGY OF OBSTRUCTIVE SLEEP APNEA

Progressive reduction in tonicity of upper respiratory tract muscles occur during REM sleep mode. This permits the tongue and soft palate to fall back in oropharynx, reducing air channel patency either partially or completely thereby pausing the inflow of air into the lungs while inhalation, causing halt in ventilation of respiratory tract. When Blood oxygen saturation level drops significantly, Respiratory centres in Brain stem initiates instantaneous arousal from sleep. During an apnea event an individual struggles to breathe and is partially awakened from sleep. These repeated arousals have sequential deteriorating impact on the anabolic phenomenon which occurs when an individual sleeps. Primary cause of OSA is obstruction in upper air channel during sleep, blockage mainly occur at rear of the tongue and epiglottis (fig 1).



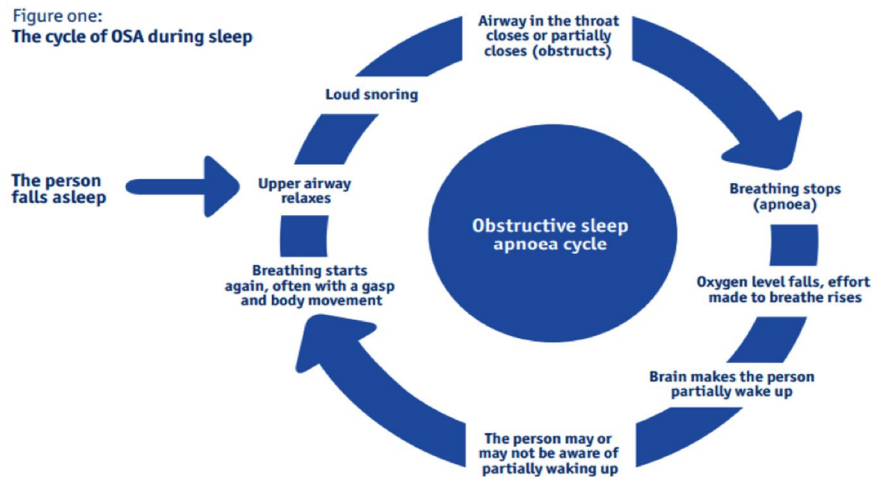
**Figure 1. Blocked Airway in supine position (OSA)**

When individual enters in lighter phase of sleep, the tonicity of throat muscles maintains patency. Airflow is smooth, soundless without any turbulence and is lamellar nature. As the upper airway blockage progresses, breathing gets noisy and turbulence in airflow increases, which is accompanied with snoring as “Venturi effect” develops along the collapsing air channel (Figure 2).



**Figure 2: Venturi Effect**

The patient's blood-oxygen saturation drops remarkably over a period until pause of sleep noises, this signifies complete airflow obstruction, this episode last from few second to several minutes. Therefore, the patient gasps air to enter in light sleep zone, thereby restoring lost muscle tone. ECT monitors record the recurring transition from REM to Non-REM sleep. The repetitive cycle of loss of muscle-tone followed by recovery of muscle-tone corresponding to REM and Non-REM modes respectively occurs during sleep (Figure 3).



**Figure 3: OSA Recurrent pathophysiologic sequence**

### Symptoms of Obstructive Sleep Apnea

- Panting at night
- Altered ability to recollect
- Overindulgent wakeful sleepiness
- Lack of centralization,
- Dribbling saliva at nighttime,
- Despondency,
- Impatience,
- Dry Mouth Syndrome,
- Decreased work Productivity
- Occupational accidents
- Reduced social interaction.

Undiagnosed OSA have been linked with exacerbations of Hypertension, Asthma, Epilepsy episodes [17]. Recent studies indicates that OSA is concurrent with cardiovascular diseases which include Hyperpiesia along with ischemic heart disease. Considering high occurrence rate along with increasing alliance with cardiovascular morbidity, Obstructive sleep apnea is deemed as community fitness issue requiring timely mediation [18].

### DIAGNOSIS HISTORY

- Recurrent arousal
- Troublesome sleep
- lack of feeling Fresh after waking up
- Trouble staying alert
- Attention, concentration, memory Deficit
- Temperament disturbances
- Increased Reaction time
- Excessive nycturia

### PHYSICAL EXAMINATION

- Corpulence
- Circumference of Neck in Men > 42cm
- Circumference of Neck in women > 37cm
- Retrognathia
- Narrow air channel
- Enlarged tonsil

- High Vaulted palate
- Deformities of Nose (deviations, turbinate hypertrophy, polyps, valve abnormalities)
- Ischemic Cardiovascular Disease
- Hyperpnea
- Body mass index >- 30kg/m<sup>2</sup>,
- Modified Mallam Pati score of 3 or 4,

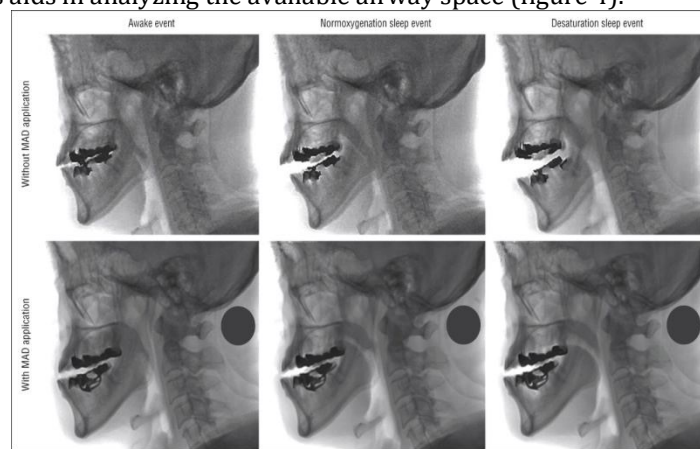
**INVESTIGATIONS**

**POLYSOMNOGRAMS**

Polysomnography is worldwide recognized as the gold standard test for establishing OSAHS. The test is conducted by recording sleep overnight, monitoring pattern of breathing and blood oxygen level. The study records posture of body, Pattern of heart rate, snoring periods, oxygen desaturation levels, along with sleep modes. The study is done by various electrodes used for recordings in electroencephalography, electro-oculography, electromyography, and electrocardiography.

Home Oximetry registers oxygen saturation levels at home. Home study can be performed at home for up to 14 days.

Lateral cephalograms aids in analyzing the available airway space (figure 4).



**Figure 4. Lateral Cephalograms**

**Computed tomography Scan :** CT scanning significantly aids in 3-D construction and volumetric assessment of upper airway by providing detailed cross sections.

**Magnetic resonance imaging provides** superior contrast images of soft tissue along with 3-D images of tissue structures, without exposing to ionizing radiation.

**Acoustic reflection test** benefits in determining the airway patency and aids in observing the response of mandibular advancement treatment enabling assessment of improvement in patency of upper Respiratory tract. The sound wave is signaled through the nasal airway which on being reflected back through the tube is captured by computer and graph is prepared that aids in the determination of position of the obstruction. (Figure 5)



**Figure 5: Acoustic reflection test with Pharyngometer**

**Spirometry** is pulmonary function test used to study pulmonary ventilation. It documents progress of airflow during inspiration and expiration.

**TREATMENT**

Can be broadly categorized into four groups. These incorporate:

- (1) Modification in Lifestyle
- (2) Mandibular Advancement Appliance
- (3) Administration of Continuous Positive Airway Pressure

#### (4) Management of Upper Airway Patency through Surgery

Lifestyle modifications incorporates managing weight, discontinuation of habits such as alcohol consumption and adopting right sleep posture.

CPAP is acronym for Continuous Positive Airway Pressure. Highly efficient treatment modality in the management of Obstructive sleep apnea. However, acceptance with nasal CPAP (Figure 6) varies from individual to individual in apnea patients as the apparatus is bulky and expensive.

**Figure 6. Airing mini-CPAP**



Oral Appliances provide noninvasive option in treatment of individuals diagnosed with sleep apnea [14]. Three concepts incorporated into dental appliance can improve the airway [19]. These concepts can either be used individually or combined to improve the patency during episodes.

**Soft palate lifting Appliance** – the prosthesis prevents airflow turbulence by lifting the soft palate, all the while an individual sleep [20].

**Tongue retention Appliance**–. Engages Tongue musculature which simultaneously positions the mandible inferiorly [21].

**Mandibular repositioning – (MRAs)** (Figure 7) positions mandible antero-inferiorly thereby bringing tongue forward by opening the posterior airway. This guidance increases superior airway space.

**Figure 7: Mandibular Repositioning Device**



**The Tongue Retaining Device** was first introduced in the year 1979. Soft polyvinyl material is used to fabricate it. The design incorporates bubble (Figure 8). Custom fitted grooves are created around bubble to allow for teeth to rest and tongue sticks out and engages in bubble by suction supported by lips. As tongue is positioned forward collapse of airway brought by the base of the tongue is eliminated [22].

**Figure 8. Tongue retaining Device**



**Mandibular Advancement Device** (Figure: 9) made up of plastic with indentation of the teeth. Movement of the mandibular teeth allows forward positioning of mandible and enables patency of airway during sleep. Advancement achieved is reversible [23]. Titanium precision attachments are incorporated to fabricate the appliance. Attachment is embedded at the incisor level, permits progressive movement from 2 mm to 8 mm, permits lateral motion upto 6 mm and silencer system allows replacement of vertical pin height. This advantage of this appliance is that it allows adjustment in both “antero-posterior”, and “open and closed” position due to titanium hinge metal.

**Figure 9. Mandibular Advancement Device**



**The Klearway Oral Appliance** (Figure 10) brings mandible sequentially forward by utilizing a maxillary orthodontic expander. Klearway is recommended for management of snoring in mild to moderate OSA and is fully adjustable. Mandibular advancements are made in small increments which is monitored by the patient. Bilateral orthodontic expanders connect the maxillary and mandibular splints with The PM positioner. The appliance can be activated by heating under hot tap water before placing in the mouth as it is made of thermoplastic material.

**Figure 10. Klearway Oral Appliance**



The **Thornton Adjustable Positioner (TAP)** (figure11) achieves activation by screw mechanism located anteriorly towards the labial facet of the maxillary splint which permits progressive '0 mm jaw advancements. This positioner has a separate attachment for the mandibular and maxillary splint.

**Figure11: Thornton Adjustable Positioner**



**Modified Herbst Appliance** (Figure 12) design establishes connection in maxillary and mandibular splints via piston post and adjustable telescopic sleeve mechanism bilaterally. It restricts lateral movement.

**Figure12: Herbst appliance**



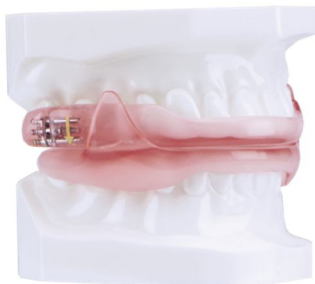
**The Elastic Mandibular Advancement (EMA)** (figure 13) occupies less volume intra orally and is concise. It resembles orthodontic retainers made up of clear acrylic, and advances the mandible in sequential steps. It is indicated in macroglossia.

**Figure 13: Elastic Mandibular Advancement Appliance**



**Dorsal Appliance** is two-part design (Figure 14). The device provides the flexibility to patients to move their mandible antero -posteriorly, speak, or even yawn while engaging the mandible in a forward position.

**Figure 14: Dorsal Appliance**



**Moses Appliance** is two-part design (Figure 15) provides various advantages including decreasing of uncomfortable muscle activity, increasing tongue space availability, and reducing parafunctional habits. It allows for lip closure, freedom to speak, and enable drinking of water while wearing it.

**Figure 15 : Moses appliance**



**ProSomnus® Sleep and Snore Device** is. CAD/CAM technology fabricated custom made antsnoring appliance (figure 16). Their two-part structure allows enough space within the mouth so that the tongue can rest comfortably while one is asleep.

**Figure 16: ProSomnus appliance**



**Palatal Lift Prosthesis** (Figure 17) markedly increased the upper airway passage dimension there by eliminating snoring and ensuring patency of airway is maintained during sleep [24].

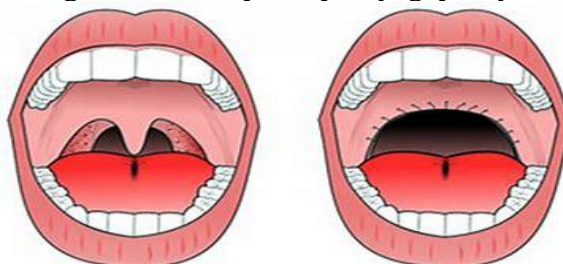
**Figure 17: Palatal Lift Prosthesis**





**Surgical Treatment:** Uvulopalatopharyngoplasty (Figure :18) and Maxillary Mandibular advancement procedures can be considered in individual with severe Apnea. The last surgical option one can resort to is tracheostomy.

**Figure 18: Uvulopalatopharyngoplasty**



According to The AASM practice neither medication nor oxygen therapy can be provided as primary care. However stimulant therapy with modafinil can be added as adjunctive therapy in those cases where after following OSA treatment residual sleepiness is observed and to which no identifiable cause is linked. Positional therapy encourages side sleeping indicated where an individual experiences worsening of symptoms during supine position [25].

### RECENT DEVELOPMENTS

Initiation of CPAP some patients who were diagnosed to have OSA progress to central sleep apnea. This is categorized as Complex Sleep Apnea Syndrome (CompSAS) and its incidence is inbetween 10% to 20%. Individual diagnosed with CompSAS are unable to accustom to CPAP due to exaggerated sleep interference resulting from central sleep apnea events. They are managed with Adaptive Servo-Ventilator (Figure 19) which is a type of PAP device.

**Figure19: Adaptive Servo- ventilator**



Provent works by incorporating principle of 1-way valve which generates consistent pressure in posterior region of pharynx. The main attribute of this device is its easy maneuver. This device (Figure20) is worn over the nostrils like a tape. This appliance has been available in the European market for management of OSA [26].



**Figure 20: Provent**

### CONCLUSION

Modern civilization competing for better living and difficulties experienced by obese people have highlighted obstructive sleep apnea as major public health issue. Addressing OSA is essential due to its association with altered perceptivity and developing cardiovascular disease risk. Obstructive sleep apnea deteriorates the quality of life of an individual along with associated family members. The Mandibular advancement appliance provides effective substitute to CPAP treatment. Appliances currently available provides options to choose from to manage sleep apnea. Oral appliances therapy is recommended for

treating sleep apnea of mild-to moderate score with a success rate of 40–50%. Snoring cannot be eliminated.

Assessment of the therapeutic benefits of oral appliance versus other modalities of treatment reflect that oral appliance present quite effective results especially in patient with mild to moderate OSA who find tolerating nasal CPAP difficult [27-30]. Prosthodontist performs a prime role in establishing diagnosis, intervention and managing patients who suffer from sleep apnea and are subjected to poor quality of sleep. Oral appliances Therapy revolves around the non-surgical intervention in the management of OSA. Compliance with MAD is higher compared to CPAP. MAD are convenient to use, economical and portable there is no requirement of additional power source. As the awareness amongst society for sleep medicine treatment options is increasing, the prosthodontists are obliged to participate in the prevention and management of OSA [31-32].

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