

## Dental considerations in obstructive sleep apnea – Retrieving current status

### ABSTRACT

Obstructive sleep apnea (OSA) is a sleep disorder caused by partial or complete upper airway collapse with hallmark features of repetitive breathing cessation resulting in reduced oxygen saturation. India ranks third among countries worst hit by OSA. OSA is linked with elevated morbidity and mortality with various modifiable/nonmodifiable predisposing factors. Different medical approaches such as polysomnography, home sleep testing, dynamic magnetic resonance imaging, drug-induced sleep endoscopy, and neutrophil-to-lymphocyte ratio assist in diagnosis. Depending on disease severity, various treatment lines have been advocated, including behavioral modifications, continuous positive airway pressure, oral appliances (OAs), and surgical intervention. The role of pharmacotherapy in OSA remains controversial and demands extensive study. OA case selection and titration need to be done with utmost care. Definite protocols for the selection of suitable candidates for OA therapy need to be established. Various invasive and non-invasive surgical interventions such as bariatric surgeries, uvulopalatopharyngoplasty and Mandibular advancement appliances (MAA) have been advocated for OSA treatment. However, MMA requires a detailed diagnosis, including hard and soft tissue examination and an adequate recovery strategy to avoid any resulting adverse facial aesthetics. Implantable upper airway neurostimulators serve as a hope for newer therapeutic approaches. The need for the hour is a multidisciplinary solution to OSA.

**Keywords:** Management, obstructive sleep apnea, oral appliances

### INTRODUCTION

Obstructive sleep apnea (OSA) is a common sleep-related breathing disorder hallmarked by repetitive episodes of nocturnal breathing cessation due to the upper airway collapse.<sup>[1]</sup> It might be associated with either complete cessation of breathing for 10 s or more (apnea) or a partial airway collapse, causing arousal or more than 3% oxyhemoglobin desaturation (hypopnea). These arousals affect the quality and quantity of sleep, often resulting in daytime sleepiness, loss of productivity, loss of cognition, and other symptoms.<sup>[2]</sup> OSA has been correlated with an increased risk of morbidity and mortality.<sup>[3]</sup> Anatomical characteristics such as maxillary or mandibular retrognathism, enlarged lower facial height, macroglossia, elongated soft palate, and inferiorly positioned hyoid bone serve as trigger factors for OSA.<sup>[4]</sup>

### PREVALENCE OF OBSTRUCTIVE SLEEP APNEA

It is estimated worldwide that approximately 1 billion out of 7.3 billion people between the ages of 30 and 69 years old may be affected by OSA. Lyon *et al.*<sup>[5]</sup> recently stated that India ranks third among countries with the highest OSA


prevalence is as high as 29 million people affected with an Apnea–Hypopnea Index (AHI) of  $\geq 15/h$ . The predominance of OSA was predicted to be 13.7% using the STOP-BANG questionnaire. It was found that the prevalence of OSA was highest in the age group of 50–59 (21.7%) years and least in the age group of 18–29 (12.0%) years. Gender-wise

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distribution of OSA was seen more among males (14.8%), while females showed a prevalence of 12.9%.<sup>[6]</sup>

### PREDISPOSING FACTORS OF OBSTRUCTIVE SLEEP APNEA

Certain factors aggravate the risk of OSA:<sup>[7]</sup>

- Obesity
- Structural abnormalities that affect upper airway patency
- Retrognathic mandible
- Adenoids
- Micrognathia
- Enlarged tonsils
- Macroglossia
- Increasing age
- Male gender
- Alcohol and Smoking
- Sedatives.

### PATHOPHYSIOLOGY OF OBSTRUCTIVE SLEEP APNEA

Although alterations in ventilator and neuromuscular control mechanisms can reduce airway patency, anatomical abnormalities play a key role in elevating the risk of pharyngeal collapsibility during sleep.<sup>[8]</sup> Literature suggests that individuals with OSA present with an impairment in genioglossus muscle function. An inspiratory effort during sleep roots for the prolapse of the tongue against the posterior wall of the pharynx, which invaginates and occludes the airway during sleep. An obstruction in nasal airflow is associated with an elevated inspiratory effort and an increased negative pressure in the pharyngeal wall airway. This suction results in increased pharyngeal airway collapsibility [Figure 1].<sup>[7]</sup>

### GENERAL SIGNS AND SYMPTOMS

#### Dental signs and symptoms of obstructive sleep apnea

- Presence of wear patterns on opposing incisors indicates the possibility of anterior positioning of the mandible to open the oropharynx

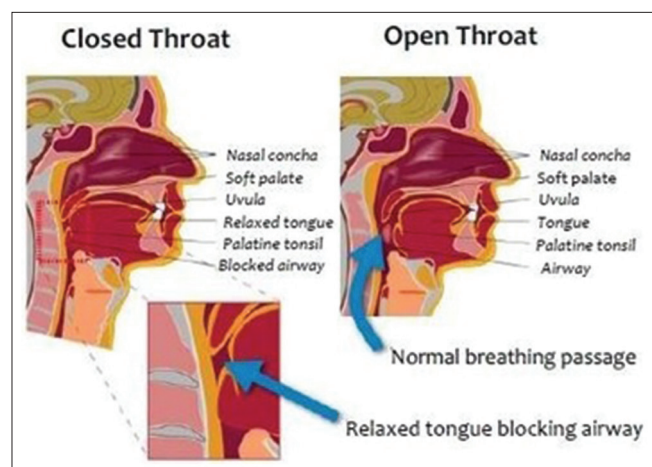


Figure 1: Negative pressure increase in the pharyngeal wall airway<sup>[7]</sup>

- Anterior teeth mobility which is not in coordination with the patient's general/oral health
- In a periodontitis-prone patient, increased loss of bone may be seen/exaggerated in sites of unusual wear or mobility
- Crenulations present on the tongue due to forward and lowered tongue position facilitating the opening of the oropharyngeal airway
- Development of anterior or lateral open bite due to altered tongue posturing
- Development or elevation of sleep bruxism
- Morning headache, tenderness in the orofacial area, and/or masticatory muscle fatigue may be seen on after awakening
- Enlarged tonsils, a large uvula, a tongue-obstructed or narrow airway may be seen on examination
- Dry gingiva may be seen as a result of oral breathing during sleep.<sup>[9]</sup> General symptoms seen are cited in Table 1.

#### Existing clinical measures of obstructive sleep apnea

In-laboratory polysomnography (PSG) has been considered the gold standard for diagnosing sleep-disordered breathing. The main factor used to establish OSA severity is the AHI.<sup>[4]</sup>

#### Medical approaches for diagnosis of obstructive sleep apnea

Efficient recording of chief complaint and history taking forms the basis for OSA diagnosis. Questionnaires such as the Berlin questionnaire, Epworth Sleep Scale, and STOP-BANG have been formulated for easy and economical detection of OSA.<sup>[8]</sup> Obesity is a major predisposing factor for OSA mandates measurement of body mass index (BMI). Males with a neck circumference of  $\geq 17$  inches and  $\geq 16$  inches in women are classified as high-risk OSA group. Airway narrowing can be clinically quantified by the Mallampati score.<sup>[10]</sup> Polysomnography is a noninvasive technique requiring overnight monitoring of various physiological events, including heart rhythm, eye movements, electroencephalography, and skeletal muscle activity. Also taken into account are respiratory effort, airflow, and oxygen saturation. However, this technique is expensive, time-consuming, and requires trained personnel.<sup>[8]</sup> In addition, hospitalization might affect the individual's convenience and sleep cycle, which can dampen the reliability of the result obtained.<sup>[8]</sup>

Table 1: Most common symptoms associated with obstructive sleep apnea<sup>[7]</sup>

Nocturnal	Diurnal
Snoring	Excessive sleepiness
Witnessed apneas	Morning headaches
Choking at night	Depression/irritability
Insomnia	Memory loss
Nocturia	Decreased libido

Owing to these limitations, a home sleep test (HST) stands as an attractive alternative to PSG. HST keeps track of disordered breathing events per night but has no EEG and cannot record sleep. Furthermore, severity assessment is questionable due to difficulty identifying arousals associated with insufficient oxyhemoglobin desaturation during these disordered breathing events. Sensor failure during the night can also lead to altered results.<sup>[8]</sup> Techniques such as nasopharyngoscopy and acoustic rhinometry can assess geometries and abnormalities of the nose and nasopharyngeal area.<sup>[8]</sup> Dynamic sleep MRI can assist airway evaluation in a multiplanar fashion in the sleeping or simulated sleep stages.<sup>[8]</sup> Drug-induced sleep endoscopy (DISE) comprises unconscious sedation and upper airway endoscopic evaluation to identify structures that add to airway obstruction. DISE inferences regarding lateral walls of the oropharynx and tongue hold special importance and are a marker for surgical prognosis.<sup>[10]</sup> Nevertheless, a systematic review<sup>[11]</sup> and a multicenter cohort analysis<sup>[12]</sup> showed that there is limited evidence between the impact of DISE and surgical outcome.

#### Correlating neutrophil-to-lymphocyte ratio to obstructive sleep apnea

NLR might be a consistent marker for diagnosing systemic inflammation and establishing OSA severity.<sup>[13]</sup> A meta-analysis by Rha *et al.*<sup>[14]</sup> validated that the NLR value in OSA patients is significantly increased compared to controls. NLR of 1.62 or higher predicted OSA with a sensitivity of 56.2% and specificity of 63.1%.<sup>[14]</sup> These values demonstrated a positive relationship with OSA severity. Elevated NLR values in patients with OSA might be associated with chronic inflammation induced by hypoxia. Inspection of neutrophils collected from patients with moderate and severe OSA shows prolonged survival, linked with higher NF- B levels and poor anti-apoptotic and pro-apoptotic protein balance. Regarding the documented finding of a decrease in lymphocytes, some researchers have proposed a higher degree of physiological stress to be the cause.<sup>[13]</sup>

#### OBSTRUCTIVE SLEEP APNEA AND CHEYNE-STOKES RESPIRATION

Cheyne–Stokes respiration (CSR) is a less common form of breathing disorder branded by apneas or hypopneas and waxing-waning type of breathing pattern.<sup>[15]</sup> It is considered to be a form of central sleep apnea. A respiratory cycle of a minimum of 40 s with three consecutive central apneas and/or central hypopneas is considered CSR.<sup>[16]</sup>

OSA contributes as a risk factor for heart failure, whereas CSR is believed to be a resultant of heart failure.<sup>[16]</sup> CSR results from an unstable respiratory control center with loss of respiratory drive, whereas OSA is a consequence of obstructed upper airway and differs from OSA in its

pathophysiology.<sup>[9]</sup> Management of CSR includes optimizing the underlying trigger factors such as congestive heart failure or stroke. Continuous positive airway pressure (CPAP) and adaptive servo-ventilation stand effective for CSR management.<sup>[16]</sup>

#### GRADING OF OBSTRUCTIVE SLEEP APNEA

OSA is graded using the AHI index and respiratory disturbance index (RDI) scoring system. AHI is the average number of disordered breathing events recorded per hour [Table 2]. RDI is the number of apneic events seen per hour and hypopnea events/hour plus the number of respiratory-effort-related arousals (RERAs) per hour of sleep.<sup>[10]</sup>

$$AHI = \text{number of apneas} + \text{hypopneas} / \text{total sleep time}$$

$$RDI = \text{number of apneas} + \text{hypopneas} + \text{RERAs} / \text{total sleep time}$$

Treatment options for OSA:

**Obstructive sleep apnea is negatively linked with quality of life and directly related with motor vehicle accident<sup>[17]</sup>**

Treatment of sleep-disordered breathing can be categorized into:<sup>[18]</sup>

1. Lifestyle alteration/behavioral therapy, i.e., weight loss, cessation of alcohol consumption in the evenings, and sleep position training
2. CPAP therapy
3. Oral appliances (OAs)
4. Surgical intervention.

#### Behavioral therapy

Behavioral treatments include weight loss, positional therapy (PT), and avoiding consumption of alcohol and/or sedatives before bedtime.<sup>[18]</sup> It has been widely documented that alterations influence the severity and frequency of the obstructive events in the anatomical and/or physiological mechanisms during sleep. The supine position exhibits an increase in apneas/hypopneas due to the gravity-influenced part of the tongue and soft palate.<sup>[19]</sup>

About 30%–50% of OSA patients are known to suffer from postural OSA where obstructive events are observed primarily in the supine position. PT techniques such as “tennis-ball technique” involve a tennis ball strapped to the patient’s

**Table 2: Apnea-Hypopnea Index<sup>[10]</sup>**

Severity index of OSA	AHI range
Normal (for adults)	AHI < 5/h
Mild OSA	5-14.9/h
Moderate OSA	15-29.9/h
Severe OSA	≥30/h

AHI: Apnea-Hypopnea Index, OSA: Obstructive sleep apnea

back to prevent supine positioning, employment of supine alarm devices, and usage of positional pillows like mattress and pillow for prone positioning have been suggested.<sup>[18]</sup> There are also commercially available FDA-approved devices such as PT devices (Zzoma) and sleep positioner alarm systems (Night Shift™).<sup>[10]</sup> Although PT enjoys better patient compliance, clinical benefits of this treatment show less competence compared to CPAP.<sup>[18]</sup>

### Role of pharmacotherapy in obstructive sleep apnea management

Several drugs such as serotonin agents, nicotine, methylxanthine derivatives, nasal decongestants, inhaled corticosteroids, and leukotriene antagonists have been proposed to manage OSA. The mechanisms through which pharmacological agents that might work are reducing REM sleep interval, increasing upper airway muscle tone, stimulation of the hypoglossal motor neurons by an increased amount of serotonin in the brain, blockage of adenosine receptors, and stimulation of ventilator drive.<sup>[20]</sup> Oxygen treatment has been recommended as an adjunct, but usage requires thorough documentation, especially in morbid respiratory patients. Modafinil, which is a psychostimulant, helps in reducing excessive daytime sleepiness by inducing alertness through the alpha-adrenergic receptor. Modafinil may be advised in addition to effective CPAP therapy when other reasons for excessive sleepiness have been ruled out.<sup>[21]</sup>

However, the role of pharmacotherapy remains uncertain, and the efficacy of proposed pharmacotherapeutic treatments for OSA has not been established.<sup>[11]</sup> Scarcity of data (i.e., deficient number of large-scale randomized controlled trials), variation between actual and perceived benefits, and side effects of the medications have shadowed the widespread prescription of drugs.<sup>[22]</sup> Thus, pharmacologic treatment may serve as adjunctive therapy but not as monotherapy.<sup>[23]</sup>

### Continuous positive airway pressure

Continuous positive airway pressure (CPAP) stands as the most efficient and therefore, the first management line for a significant group of patients with OSA. CPAP has demonstrated alleviation of symptoms and reduced risk of occupational and traffic mishaps. CPAP also positively affects elevated sympathetic activity and hence, minimizes the threat of cardiovascular illness, especially arterial hypertension.<sup>[24]</sup>

Although CPAP is the most widely utilized and reliable therapeutic modality, it is also the most cumbersome.<sup>[22]</sup> It has been documented that CPAP has compromised patient compliance due to portability issues, motor-generated noise, and the discomfort caused by the mask. Unfortunately, 46% to 83% rates of nonadherence (adherence is outlined by the

use of CPAP for four or more hours per night) have been documented [Figure 2].<sup>[11]</sup>

### Oral Appliances (OAs)

OAs are used during sleep to prevent the oropharyngeal tissues and the base of the tongue from obstructing and collapsing the upper airway. Functional devices and mandibular advancement OAs are considered to be the first line of management for OSA patients who favor OAs over PAP and candidates who do not show good response to PAP.<sup>[25]</sup>

OAs are categorized into:<sup>[26]</sup>

- Soft palate lifters
- Tongue-retaining devices (TRDs)
- Mandibular advancement appliances (MAA).

### Soft palate lifters

This group of appliances works by elevating the soft palate and uvula to reduce soft palate vibrations. However, its effectiveness has little evidence.

### Tongue-retaining devices

The device consists of a bulb into which the patient is instructed to protrude and insert the tongue. A vacuum must be present to retain the tongue in the hollow bulb. The device is fabricated using a flexible vinyl material from which air can be squeezed out to attain a vacuum.<sup>[27]</sup>

Their usage is limited by periodontal disease, number of remaining teeth, <25 mm of maximum vertical mouth opening, tori, etc., precluding the construction of mandibular advancement appliance. Tongue Retaining Devices (TRD) is an excellent device for edentulous patients or those who suffer from temporomandibular joint sensitivity [Figure 3].<sup>[27]</sup>

Example: Aveo Tongue-stabilizing device, SNOR-X, and nose breathe appliance.



Figure 2: Continuous positive airway pressure<sup>[27]</sup>

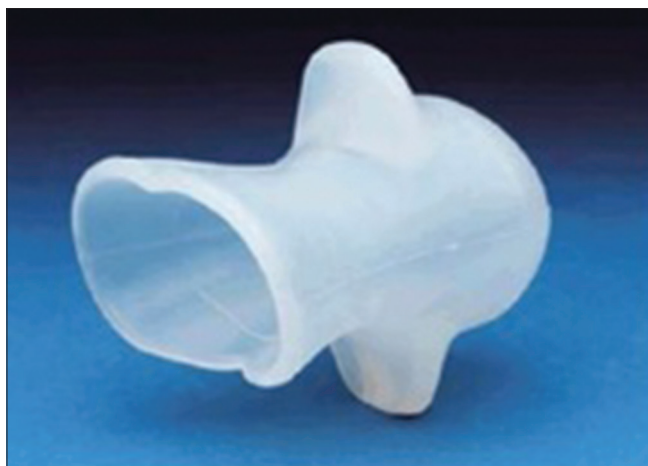


Figure 3: Tongue-retaining device<sup>[27]</sup>



Figure 4: Titratable two-piece device-Silent Nite<sup>[4]</sup>

### Mandibular advancement appliances

MAA is the most frequently used dental appliance today. It mechanically protrudes the mandible and the attached tongue forward, thereby increasing the cross-sectional dimension of the upper airway, thus preventing or minimizing the risk of upper airway collapse while sleeping. Effective mandibular advancement span from 6 to 10 mm or from 65% to 70% of maximum protrusive potential.<sup>[26,27]</sup> These devices can be either.<sup>[27]</sup>

- i. Fixed/single position/nontitratable (i.e., the protrusion distance cannot be altered)/single-piece device. Examples: Therna Snore, Esmarch appliance, nocturnal airway patency appliance, mandibular-inclined repositioning appliance, clasp-retained mandibular positioner, elastomeric appliance, Sleep Apnea Goldilocks Appliance, SnoreFree, and SnoreGuard
- ii. Variable/adjustable/titratable (i.e., the protrusion can be adjusted according to the requirement)/two-piece device. Examples: Adjustable PM positioner, Klearway appliance, Herbst appliance, Thornton adjustable positioner, elastic mandibular advancement appliance, Hilsen adjustable appliance, silencer, Respire-Dorsal fin appliance, SomnoGuard, and Silent Nite [Figure 4].<sup>[27]</sup>

The ideology of custom-made MADs has come a long way from a rigid “monobloc” toward the now available “Duo bloc” types. The monobloc MADs sometimes cause temporomandibular discomfort. The upper and lower parts of the titratable MADs are separate but dynamically interconnected and give scope for fine-tuning mandibular advancement.

### Oral appliance titration

The ideal range for mandibular protrusion needs to be established for each patient in tolerability versus efficacy.<sup>[26]</sup> In the first appointment, OAs advance the

mandible approximately to two-third of maximum protrusion. After acclimatization, grounded on patient feedback regarding symptoms and sleep quality, the protrusion can be titrated or increased until optimum comfort is acquired. It is typically suggestable to carry out a sleep test with the OA in place.<sup>[27]</sup>

### ADVERSE EFFECTS

#### Immediate effect

Hypersalivation, tooth discomfort, myofascial pain, and muscle tenderness for a brief time after awakening are commonly reported initially and may hinder early OA acceptance.<sup>[27]</sup>

#### Change in occlusion

Occlusal changes are developed with OA usage. Since many patients will be treated for an extended period, OA-generated malocclusions often become prominent in the long run and might necessitate orthodontic therapy to reverse the acquired dentoskeletal variations. Distinctive changes include a reduction in overjet, overbite, altered facial height, anterior cross-bites, and posterior open bite.<sup>[27]</sup>

#### Combination therapy

Several studies have proposed combining PT with OAs for treating postural OSA. Literature suggests that combination therapy of MAD and PT shows superior efficacy than individual treatment efficacy.

### Surgical approach for management of obstructive sleep apnea

Various surgical options for OSA alleviation aimed at bypassing through tracheostomy/modifying the site of obstruction (majority of the procedures) and indirectly treating OSA (bariatric surgery) have been documented.<sup>[10]</sup> A recent meta-analysis documented that an OSA patient benefitted from bariatric surgery and nonsurgical weight

**Table 3: Treatment of obstructive sleep apnea based on severity<sup>[10]</sup>**

	<b>Mild OSA (AHI/RDI 5-14.9)</b>	<b>Moderate OSA (AHI/RDI 15-29.9)</b>	<b>Severe OSA (AHI/RDI ≥30)</b>
Primary treatment	Observe (asymptomatic) positional therapy oral appliance surgery - UPPP	PAP	PAP
Secondary treatment	PAP	Oral appliance or surgery - UPPP	Surgery - MMA or oral appliance
Adjunctive	Weight-loss positional therapy	Weight loss positional therapy	Weight-loss positional therapy

AHI: Apnea-Hypopnea Index, OSA: Obstructive sleep apnea, RDI: Respiratory disturbance index, UPPP: Uvulopalatopharyngoplasty, PAP: Positive airway pressure, MMA: Maxillomandibular advancement

loss through improvement in BMI and AHI; however, bariatric surgery showed more significant improvement than nonsurgical alternatives.<sup>[28]</sup>

As airway obstruction can occur at different positions, varying levels of surgical intervention exist, ranging from minimally invasive procedures (under local anesthesia as an outpatient procedure) to more invasive processes undertaken at nose level, tongue, oropharyngeal tract, and craniofacial structures.<sup>[17]</sup> Uvulopalatopharyngoplasty, either conventional or laser-assisted uvulopalatoplasty (LAUP), can be done to remove excess tissue in the oropharyngeal tract in selected OSA patients. Velopharyngeal insufficiency has been reported in almost one-third of patients, other long-term complications including dryness of the throat and dysphagia.<sup>[17]</sup>

Maxillomandibular advancement (MMA) is generally advocated only for patients with severe OSA who fail to tolerate PAP therapy in addition to patients who also have an orthodontic indication for the procedure. The severity of OSA is not the only criteria for MMA candidacy; detailed orthodontic evaluation inclusive of comprehensive soft tissue facial evaluation and treatment planning should be carried out for such patients to ensure optimal presurgical preparation and to prevent any adverse effect on facial aesthetics.<sup>[25]</sup> In OSA patients with deficit maxilla in the transverse dimension, surgically assisted rapid maxillary expansion (SARME) along with comprehensive orthodontic treatment helps attain good functional and esthetic occlusion with improved PSG readings [Table 3].<sup>[26]</sup>

### POSSIBLE TREATMENTS IN THE HORIZON

Mini-implant-supported expansion may serve as a practical adjunctive for the management of adult OSA patients. However, future studies and sufficient PSG evidence are still awaited.<sup>[26]</sup>

A recent FDA approved; Upper Airway Stimulation (Inspire®) is emerging as a promising treatment modality employing an implantable neurostimulator that stimulates the upper airway. It stimulates the hypoglossal nerve and therefore, the genioglossal muscle during the patient's breathing leading to protrusion of the tongue and palate. This helps maintain an open airway. It might be indicated in carefully selected patients with moderate-to-severe OSA with a BMI score <32.<sup>[10]</sup>

### SCOPE OF FURTHER RESEARCH

Progressive research into the physiology of a supine sleep apnea patient may help formulate approaches for categorizing the best candidate for OA therapy.<sup>[26]</sup>

### CONCLUSION

If left untreated, OSA may have a variety of severe consequences.<sup>[25]</sup> As a result, the trained dentist should provide OSA screening in the patient's background and review. When a history of positive OSA is suspected, working with sleep medicine experts and physicians is often recommended to make urgent medical treatment simpler. Any additional titration or alternative medications should be discussed with the sleep doctors and dentist in question. If objective sleep testing suggests that treatment is ineffective, a multidisciplinary approach must evaluate the diagnosis, treatment plan, and clinical outcomes for OSA.<sup>[29]</sup>

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### Conflicts of interest

There are no conflicts of interest.

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