

INTRODUCTION

Dentistry is experiencing an increasing role in the management of patients with sleep-disordered breathing (snoring and sleep apnea). In the last decade the opportunity to expand one's practice beyond the scope of the teeth and their supporting structures has experienced many new horizons.

Now that patients have fewer cavities, whiter teeth, less pain, and a more efficient chewing ability—what is next for dentistry? The answer lies in the dentist's ability to help the patient with difficulty in breathing during the sleep cycle to gain improved airway conduit and, therefore, a more restful sleep. This issue is typical of several sleep-related breathing disorders (SRBD) that are of increased interest to the practicing dentist.

The impact of oral-appliance therapy and the emerging role of the dentist in the management of SRBD treatment can be noted in the following ways:

- recognition of a sleep disorder and the appropriate referral where indicated; the use of an oral appliance for the management of SRBD, and
- in the ability to offer surgical intervention.

This article will serve as an overview of sleep/sleep disorders with an emphasis on snoring and sleep apnea and the therapeutic use of the oral-appliance for treatment.

NORMAL SLEEP

Sleep is a distinct and unique state of consciousness with specific characteristics, and is best defined as a state of behavioral disengagement from and unresponsiveness to the environment. It is not entirely clear why we sleep. Numerous researchers and experts have studied sleep and have been able to recognize its benefits and impact, depending on the quality of that sleep. In addition, sleep stages have been defined that differ based on one's age.

Sleep also has distinct variations; REM (rapid eye movement) and NREM (non-rapid eye movement). During any given sleep period, we get varying amounts of these types of sleep in alternating proportions that are rarely consistent for any given sleep period. NREM sleep has four distinct stages that are based on brain wave (EEG) activity. The four stages display different EEG patterns and vary in quantity and duration, their occurrence during a night's sleep, and are associated with physiologic and neurologic activity. REM and NREM alternate throughout the night in 90-minute cycles about three-to-six times per night. As these cycles progress through the course of a sleep period, the amount of REM increases and the amount of NREM, particularly stage 3 and 4, decrease.

REM sleep is where dreams occur. During this stage the eyes move rapidly and the body is in a state resembling paralysis. The muscles are usually rigid and tight. NREM sleep is where the muscles become more relaxed and the eyes no longer move rapidly. This type of sleep comprises the greatest amount of sleep time. The four stages are distinct and are best described as follows:

Stage 1:	A short transitional sleep phase that we pass through as we leave REM.
Stage 2:	This phase makes up a significant amount of sleep time (about 50%); This stage is where bruxism usually occurs, and in patients with SRBD most sleep time is spent here.
Stages 3 and 4:	Generally viewed in combination, and referred to as deep sleep, Delta sleep, slow wave sleep, or restorative sleep. Delta or slow wave sleep shows a synchronous EEG wave form that we will note as delta waves. The brain and the body are believed to get the greatest amount of regeneration during the delta wave period. This is also the stage where growth hormone is secreted and other neurotransmitters, such as serotonin, are released. The absence of this stage often relates to greater fatigue when in the waking state, an increased incidence of bruxism and SRBD as well as additional Health-related problems.

REM, NREM and other sleep stages will vary in proportion, amount, and distribution as we grow and age. Children will have more delta or slow wave sleep and the elderly will have less compared to the young adult and those in middle age. The chart shown below categorically indicates the varying proportions and changes in sleep stages throughout the aging process. Another key element of our sleep stages is dependent on our internal clock, or what is termed our 'circadian rhythm.' This internal biological clock is regulated by various factors, predominantly the light/dark cycle and our daily schedule. Like the stages of sleep over a lifetime the circadian rhythm also varies. It is different in young children, teenagers, adults, and the elderly. Young children are more prone to function in relation to the light/dark cycle. Teenagers have an altered clock that causes them to stay up later and sleep later. Adults are driven by work schedules and deadlines that often compromise their individual clock and may interfere with sleep patterns. The elderly are often compromised by pain, the natural decrease in sleep time, and the alteration in their sleep stages as determined by the aging process.

THE TYPES AND STAGES OF SLEEP ARE DEFINED AS FOLLOWS:			DISTRIBUTION OF SLEEP STAGE PERCENTAGES BY AGE GROUP COMPARED TO YOUNG ADULTS				
STAGE	QUALITY	% of SLEEP TIME	STAGE	CHILD	YOUNG/ADULT	SLEEPAPNEA	ELDERLY
REM	Dream sleep or active sleep	20-25%	Wake	Less	5%	Decreased	Increase
NREM			REM	Equal	25%	Decreased	Equal
Stage 1	Transitional sleep	5%	Stage 1	Less	5%	Increased	Greater
Stage 2	Light sleep	50%	Stage 2	Equal	50%	Increased	Greater
Stage 3	Slow wave sleep		Stage 3 & 4	Greater	25%	0%-2%	Less
Stage 4	Restorative sleep or Delta sleep	20-25%					

(Stages 3 and 4 are often viewed as one stage with similar qualities)

CLASSIFICATION OF SLEEP DISORDERS

The American Academy of Sleep Medicine (AASM) has created an International Classification of Sleep Disorders wherein sleep disorders are described and categorized, and ultimately can be diagnosed (1). Sleep disorders are classified into four major categories and then subcategories that allow a specific diagnosis.

<p>DYSSOMNIAS:</p> <p>Disorders that produce either insomnia or excessive sleepiness; further delineated into intrinsic sleep disorders (disorders that arise from within the person), extrinsic sleep disorders (disorders that arise external to the person), and circadian rhythm sleep disorders (those related to disruption of sleep periods over a 24-hour day). Within this category the specific disorders of interest to the dentist may be:</p> <ul style="list-style-type: none"> Obstructive Sleep Apnea Periodic Limb Movement Disorder/Stimulant-dependent Sleep Disorder Jet Lag 	<p>PARASOMNIAS</p> <p>Disorders that intrude into sleep and occur during sleep. These are not principle sleep disorders, but act to modify an individual's sleep in some manner. This group has four subcategories; arousal disorders, sleep-wake transition disorders, parasomnias associated with REM sleep, and other parasomnias. Within this category the specific disorders that may be of interest to the dentist are:</p> <ul style="list-style-type: none"> Sleep Terrors Nightmares Sleep Enuresis Sleep Talking Sleep Bruxism Primary Snoring 	<p>Sleep Disorders Associated with Mental, Neurologic or Other Medical Disorder</p> <p>Includes mental, neurologic, or other medical disorders that are associated with significant sleep disruption and/or excessive sleepiness. Within this category the specific disorders that may be of interest to the dentist are:</p> <ul style="list-style-type: none"> Sleep-related Headaches Sleep-related Gastroesophageal Reflux Fibromyalgia 	<p>Proposed Sleep Disorders:</p> <p>Sleep disorders for which there is an inadequate amount of research or information to confirm their existence as separate entities with unique qualities. Examples include:</p> <ul style="list-style-type: none"> Long Sleeper (sleeps more than 10 hours per day, routinely) Short Sleeper (sleeps less than 5 hours per day, routinely)
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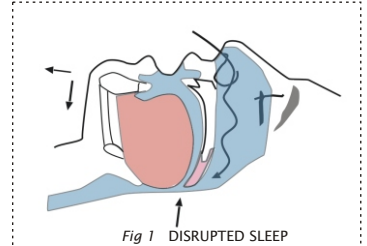
In order to focus on the disorders related to sleep and breathing (SRBD) this article will emphasize areas in which the dentist and their staff may have the most impact and have the potential to be involved in patient management. These include snoring, sleep apnea, and sleep bruxism. The dentist who becomes more involved in the co-management of these and other sleep disorders will, in time, develop an increased awareness of the variations in sleep disturbances and the appropriate referral in regard to them.

BREATHING RELATED SLEEP DISORDERS

Sleep-related breathing disorders (SRBD) are common in our society, and are most frequently defined and observed as snoring and sleep apnea. Other, related conditions may appear as well.

Currently, it is estimated that 44% of males and 28% of females are habitual snorers. It has been estimated that by the age of 40, 40% of all males and 20% of all females snore and by age 60, 60% of all males and 40% of all females snore. In addition it is estimated that 24% of men and 9% of females meet the minimum criteria for a diagnosis of sleep apnea and also have daytime hypersomnolence (2). One study found that roughly 8% of the population bruxes during the night, while another study demonstrated a 6.5% to 88% incidence, and appears to have an increased incidence of occurrence with individuals who also snore or have sleep apnea(3).

During wakefulness, the airway is maintained in an open state as dictated by one's posture and by neuromuscular compensation. During sleep the posture changes and this compensation may be lost. Gravitational changes force the airway and structures in the airway to narrow, collapse, or become totally obstructed. The diagram shown (Fig. 1) demonstrates what happens when the normal airway collapses or narrows.



The narrowed airway makes breathing difficult and uncomfortable. In addition, because of this narrowing, air must pass through the airway at an increased rate of speed for the individual to take in the same quantity of air. This is referred to as the Bernoulli principle and is the outcome when a tube of a given diameter narrows, but must still take in the same volume of a substance and does so with increased speed. As this occurs, there is an increased potential for noise to occur because of the vibration of the tube. In the airway, the sound is snoring. If the tube becomes entirely obstructed this is apnea.

In addition to this narrowing or collapse, there is an associated increase in the negative intrapharyngeal pressure during inhalation. This increased negative pressure leads to a suction-type effect that can further close or narrow the airway, which then creates the possibility of further collapsing the airway by the pressure that is placed on the tissues and structures in the airway, including the tongue, soft palate, uvula, and the collapsible part of the airway just below the base of the tongue.

SNORING

A condition associated with a loud vibrating sound that occurs during inhalation due to narrowing of the airway. Commonly associated with sleep position, large tonsils and/or adenoids or a large tongue and an enlarged uvula or soft palate.

SLEEP APNEA

Snoring may be a sign of sleep apnea. Sleep apnea is defined as the total cessation of breathing for 10 seconds or longer. Sleep apnea has three types:

OBSTRUCTIVE

Defined as the absence of breathing due to a total collapse and obstruction of the airway despite ongoing respiratory effort. This is the most common type of apnea.

CENTRAL

The cessation of breathing associated with a lack of respiratory effort.

MIXED

A combination of obstructive and central.

The measurement of the severity of the apnea is termed the apnea index (AI) or the respiratory disturbance index (RDI). The AI is the average number of apneas per hour of sleep and the RDI is the average number of combined apneas and hypopneas (discussed below) per hour of sleep. Hypopnea refers to a form of disturbed breathing that is defined as a partial obstruction of the airway (obstructive hypopnea). The RDI is sometimes referred to as the respiratory distress index or the apnea-hypopnea index (AHI). Typically an AI of 10 or more indicates the presence of sleep apnea and an RDI of 5 or more also indicates sleep apnea. Depending on the number of AI's or RDI's the patient is then determined to have mild, moderate, or severe sleep apnea. The AASM's definition of hypopnea is a 50% reduction in airflow or respiratory effort in conjunction with a 4% or greater oxygen desaturation (fall in blood oxygen level) or an EEG arousal. Because the AI and RDI are linked, the condition is often defined as Obstructive Sleep Apnea Hypopnea Syndrome.

Common Signs and Symptoms of OSAHS

- Daytime Fatigue
- Excessive Daytime Sleepiness (EDS)
- Habitual Snoring
- Witnessed Apnea by the bed partner
- Nocturia
- Impotence or Loss of Sex Drive
- Morning Headaches
- Memory Loss (mainly short term)
- Anxiety
- Increased blood pressure
- Irritability

Another SRBD that is often recognized is a condition termed Upper Airway Resistance Syndrome (UARS). This condition was first described a number of years ago, and is a condition associated with disrupted breathing because of increased resistance in the airway due to limitation of air flow. Snoring often accompanies UARS. The cardinal findings that delineate UARS from apnea is that it occurs without apnea or oxygen desaturation. The patients often complain of daytime fatigue and feel tired. Another term that often has more recently been associated with this is Respiratory Effort Related Arousals (RERAs). UARS and RERA appear to be related because the events are shorter and they are associated with EEG arousals.

TESTING FOR SLEEP DISORDERED BREATHING

The most common test for the sleep-disordered patient is the Polysomnogram or FSG. This test is typically done in a sleep center, overnight. The patient is hooked up to various leads and electrodes that register changes in EEG activity, measure blood oxygen levels or saturation, measure blood pressure, determine eye movement, and measure respiration. The results of this type of testing is termed a sleep study, the reading of which leads to a diagnosis.

Another type of measurement that in some instances is used is termed Pulse Oximetry. This device can be used in the home and measures blood oxygen levels or saturation and the pulse during a night's sleep. This type of testing is considered a screening, and is not looked upon as a definitive means by which sleep-disordered breathing can be diagnosed.

There are other types of testing that have become well-recognized, involve much less cost, and can be done in the home. Many of these types of tests are ways to screen patients that may be less severe and can also be used as follow-up procedures to determine the effectiveness of the treatment, such as an oral appliance.

CHILDREN AND SLEEP DISORDERED BREATHING

Children have historically been overlooked when it comes to snoring and sleep apnea. Recently there has been an increased emphasis and awareness of SRBD in children. Many children may have other types of sleep problems, but snoring and sleep apnea are the most common. When a child is sleepy, snores, and does not get a good night's sleep it is prudent to refer them for a sleep study or a consultation with a physician who specializes in sleep medicine.

Symptoms in Children with SRBD

Many children have some key health factors that are representative of SRBD. Observation and examination of these children might cause the physician or dentist to be suspicious of an SRBD. Some of the conditions that are key factors in a child who has a sleep-related breathing disorder that might result in the symptoms mentioned above are:

Many of these children may actually have UARS as opposed to true apnea. Because of the coexistence of these conditions it might be prudent for the child to have an overnight sleep study. In children the AI and RDI normal values are not the same as for adults. The recognized values that indicate OSAHS in children are: (5)

Night-time	Day-time
Snoring	Neurocognitive Impairment
Bruxism	ADHD or ADD symptoms
Awakenings	Hyperactivity
Mouthbreathing	Behavioral issues (irritable)
Nightmares	Tired Poor School Performance

- Enlarged Tonsils and possibly the Adenoids
- Obesity
- Micrognathia or what appears as a small Maxilla or Mandible
- Retrognathia, especially of the Mandible
- Allergy

AI 1 or greater

RDI 5 or greater

Oxygen desaturation less than 92%

THE DENTISTS ROLE IN SCREENING

The practicing dentist has the opportunity to practice sleep dentistry within the already existing practice. The key elements indicated for success in this area are: stay current regarding the patient history, be observant of intraoral findings that are suggestive of SRBD, and begin an increased level of communication with the patient's physician as well as those who practice sleep medicine (6). The history can easily be modified to allow the dentist to determine if the patient is in fact at risk. The key questions to be asked by the dentist, the hygienist, or the staff are in asking these questions, it is important to be aware of the main conditions associated with, and putting the patient at an increased level of risk for SRBD. They are:

- Neck size :** in a male 17" or greater and 15 1/2" or greater in a female is indicative of increased risk.
- Obesity :** an increase in body weight relates to an increase in fatty deposits At the lateral areas of the airway thus decreasing airway size.

History of snoring, especially before the age of 50, witnessed apnea by the bed partner.

SLEEPING APNEA SCREENING

1. **Snoring:**
 - I. **Do you snore on most nights (more than 3 times weekly)?**
Yes (2) No (0)
 - II. **Is your snoring loud (can be heard outside your bedroom)?**
Yes (2) No (0)
2. **Has it been reported to you that you stop breathing, gasp or Choke while asleep?**
Never (0) Occasionally(3) Frequently(5)
3. **What is your neck size (collar of a shirt)?**
Male : less than 17" (0) 17" or more (5)
Female : less than 15 1/2" (0) 15 1/2" or more (5)
4. **Are you being treated for high blood pressure or has it risen recently?**
Yes (2) No (0)
5. **Do you occasionally doze off or fall asleep during the day when:**
 - I. **You are not busy or active?**
Yes (2) No (0)
 - II. **You are driving or stopped in traffic, such as a red light?**
Yes (2) No (0)

Total score :

CLINICAL EXAMINATION OVERVIEW

Clinical Findings	What it Means
Large tongue	May be obstructing the airway especially when lying down.
Tongue coated	Many SRBD patients have associated gastric esophageal reflux which causes the tongue to be coated on the poster one-half.
Reduced or absence Gag reflex gag	Often times snorers and sleep apnics have lost their reflex due to of alternations in the soft palate and the uvula.
Large uvula/ touches back of tongue	Uvula is swollen, possibly due to snoring, may be causing some obstruction.
Tongue obstructs view of uvula/ soft palate	This has been determined to be a possible predictor of SRBD and sleep apnea.
Large Tonsils	Structures are probably obstructing airway.
Narrow airway	More likely to have SRBD due to restriction of the width.
Swollen soft palate	May be obstructing the airway, may be swollen due to snoring.
Tooth wear and recession (Abfraction)	Probably is a bruxer and/or clencher, has an increased risk for SRBD

RESULTS

- 5 points or less :** Low probability of sleep apnea, patient is probably a primary snorer and would benefit from oral appliance therapy. If OA treatment is done, keep patient's physician advised.
- 6 to 8 points :** Gray area, may wish to discuss this with the patient's physician before proceeding with any treatment.
- 9 points or more:** Order a sleep study or, refer to a sleep doctor or, refer the patient to their physician and advise of the findings.

Increased involvement in this field allows the dentist greater flexibility in recognizing sleep disorders and the patient who may have them. The doctor will also recognize that the patient may have a sleep disorder that is not necessarily one they can manage, and can then successfully refer the patient for appropriate management of the condition.

The more common sleep disorders may be more easily recognized by the dentist. They include: insomnia, restless limb syndrome, and narcolepsy. In addition, there are many people who have related health issues, and have never been afforded the awareness of the possible link to a sleep disorder. This may ultimately result in an increase in services by the practicing dentist for this patient in terms of possible OA treatment or splint therapy for bruxism or TMJ.

TREATMENT OPTIONS

There are three main methods of treatment for SRBD in patients who have been diagnosed using an overnight sleep study. These are:

- Nasal Continuous Positive Airway Pressure (nCPAP)
- Oral Airway Dilator Appliances
- Surgery

When a patient has had an overnight sleep study and does not have apnea, the treatment for the snoring is often an oral appliance or surgery. However, some patients will opt for no treatment because they do not perceive they have a problem or because they simply do not wish to do the treatment. Other options for managing SRBD are weight loss, smoking cessation, decreased alcohol use, more exercise, and an attempt to better regulate the sleep/wake time. Often these are very difficult and require a great deal of effort by the patient. As such, they are usually not successful.

Nasal CPAP

This has, and continues to be, the gold standard treatment for sleep apnea. It is hardly ever used for snoring. The treatment is carried out by placing a mask over the nose and securing it tightly with straps to prevent air leaks. A small generator forces air through a tube attached to the mask and pneumatically opens the airway with air pressure. Many patients cannot tolerate the mask, the restriction in their sleep, and the closed-in feeling they may have. In addition, the bed partner now has to trade off the sound of the generator for the snoring. Despite its problems, when CPAP is used on a routine basis through out the night the results are quite good.

Especially fabricating splints for TMJ or bruxism, this type of treatment is an easy transition and affords additional services for patients who are currently untreated.

Surgery

Surgical treatment of the airway SRBD has historically been thought to be the second-line treatment for snoring and sleep apnea when the patient fails CPAP. At this time, surgery does not have the same success that CPAP, and does not have the success rate that can now be expected from oral appliances.

Surgery is mostly soft tissue in nature, and is done so as to revise soft-tissue relationships or to reduce excess or unwanted tissue. Probably the most successful surgery is a tonsillectomy in a child with SRBD. Aside from that, most surgery of the uvula, soft palate and tongue is less than 50% successful overall. In addition, many of these surgeries are quite painful with a lengthy healing period and sometimes need to be repeated. The most common soft-tissue surgery is the Laser Assisted Uvulopalatoplasty (LAUP), the Uvulopalatal Pharyngoplasty (UPPP), and the Hyoid advancement.

The one surgical procedure that has been proven to be very successful is a maxillary and mandibular advancement procedure. This is very involved and costly surgery compared to other conservative therapies.

Oral Airway Dilator Appliances: Oral appliances (OA) is a form of therapy that can best be delivered by the dentist. Over the last ten or so years the acceptance of OA as an effective alternative to CPAP and surgery has been well documented. Numerous clinical studies have described the usefulness as well as the compliance of this treatment. (Fig. 2). OA has two distinct and well-defined types:

The Tongue Retainers: (TRDs) are made out of a soft, flexible material that does not fit teeth tightly. The front of this device is a bulb or concave part, into which the patient sticks their tongue. This holds the tongue forward while sleeping. These devices were developed in the early 1980's, and were based on the theory that the tongue would fall back into the airway, and therefore, was the sole culprit in the presence of airway narrowing causing the snoring and apnea. At this time, these devices are used infrequently and do not make up the bulk of the devices used today. In the opinion of the author, these devices are reserved almost exclusively for patients who are edentulous and/or have confirmed macroglossia.

The Mandibular Repositioners: (MRDs) comprise a wide variety of devices and appliances, most of which are two-piece and fit both the top and bottom teeth. They are constructed and connected in a manner that allows both vertical opening and anterior repositioning, as necessary, to effectively dilate or open the airway. In the last few years it has become apparent that vertical opening with minimal anterior repositioning offers the most optimum result in many patients. Research has shown that these appliances can open the airway by placing a pull on the musculature that supports the airway and is related to the mandible.

Figure 1 exhibits the airway of the SRBD patient. When the appliance is in place, the airway is opened and demonstrates a more normal configuration (Fig. 3). In addition, imaging studies have shown that the lateral dimension of the airway is more critical than the anterior-posterior dimension in terms of managing the SRBD, which is what the OA has been shown to effect.

Many of the MRDs on the market today are custom-fabricated. This requires a set of impressions, a jaw registration at the desired vertical, along with the desired anterior position of the mandible as the starting point for treatment. It is then sent for laboratory fabrication. A new generation of appliance is becoming available both and fit. It maintains the upper and lower configuration and it can be fabricated in the dental office as an immediate device. This type of appliance fits the teeth in a custom manner like the laboratory-fabricated devices without the need for a laboratory step.

Most experts in the use and delivery of MRD indicate there are five criteria that offer the most optimum result, and should be taken into consideration when deciding on which oral appliance to use for the patient. These are:

- Adjustability : The appliance should be able to be adjusted in cases where dental work is done or the fit is not exactly correct.
- Titrateable : If a given or initial jaw position is not causing the desired result, then the appliance should be easily modified to create the optimum result.
- Posterior Support : The appliance should have support in the posterior to prevent TMJ dysfunction or symptoms.
- Full Tooth Coverage : All of the teeth should be covered to prevent undesired tooth movement.
- Jaw Mobility : The mandible should be able to move during the night. Being locked into a restricted position may cause pain in the jaw muscles.

The successful use of an oral appliance for the management of SRBD is quite straightforward for the practicing dentist. For the dentist presently fabricating splints for TMJ or bruxism, this type of treatment is an easy transition and affords additional services for patients who are currently untreated.

CONCLUSION

The dentist's role in recognition and management of SRBD is growing rapidly. The development of better oral appliances will allow the dentist to deliver even better, more predictable results in the future. The dentist's role is key in the advancement of treatment programs and patient awareness in the management of sleep-related breathing disorders, and there is great opportunity for all who wish to take part in this exciting and rewarding service. The advent of Dental Sleep Medicine is now a major part of the 21st century and for decades to come.

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