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On the edge between medicine and dentistry: review of the dentist's role in the diagnosis and treatment of snoring and sleep apnea

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Objectives: Snoring and obstructive sleep apnea syndrome (OSA) can affect both esthetics and health. In this review article, we describe the role of the dentist in evaluation and treatment of snoring and OSA in children and adults, with an emphasis on oral appliances as a means to treat the adult population. **Data Sources:** A comprehensive literature search of publications from 1934 to 2013 in the PubMed/Medline/Science Direct databases was performed to collect information about snoring, OSA, and oral or dental appliances using these terms as key words. The search was limited to peer-reviewed

articles written in English, with a few exceptions in other languages. The literature search was endorsed by manual searching through peer-reviewed journals and reference lists of the selected articles. **Conclusion:** The dentist's role in the diagnosis of OSA in children and in diagnosis and treatment in the adult population with the help of oral appliances is vital. Diagnosis and treatment by the aware dentist can reduce major health risk outcomes. (*Quintessence Int* 201#;##:69–77; doi: ##.###/j.qi.a#####)

Key words: obstructive sleep apnea, oral appliances, snoring

Snoring affects about 20% of the adult population; 24% of men and 14% of women. The incidence rises to up to 50% in men over 60 years old.¹ The underlying mechanism involves sleep-induced hypotonus that causes vibration of the soft tissues in the upper airway, a drop in intrapharyngeal pressure, and narrowing of the air column during inspiration.² The disturbance may origi-

nate at different anatomic levels, and it may be intermittent or continuous.

Moreover, this health problem can be a symptom or can lead to a more severe disorder called Obstructive Sleep Apnea syndrome (OSA). OSA is characterized by repetitive full or partial cessations of airflow during sleep, followed by a reduction in blood oxygen saturation.³ These events happen despite persistent ventilator effort, as demonstrated by contraction of respiratory muscles. The reported incidence is approximately 9% in adult men and 4% in adult women between the ages 30 to 60.⁴ The prevalence of pediatric OSA is 1% to 4% depending on the threshold of Apnea Hypopnea Index (AHI).⁵

Recurring episodes of obstruction are caused by the relaxation of upper airway dilator muscles during sleep and the loss of a patent upper airway. This may lead to

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a ventilatory effort against an obstructed (partial or complete) airway and is associated with recurrent oxyhemoglobin desaturation and arousals from sleep.^{6,7} The significance of sleep disordered breathing syndrome is its association with the development of cardiovascular morbidity,⁸ systemic hypertension,⁹ cerebrovascular complications,¹⁰ depression,¹¹ and potentially can lead to fatal road accidents.¹² Some reports demonstrated a close association between OSA and early deaths.¹³

Continuous positive airway pressure (CPAP) is recommended for adults as the treatment of choice for moderate and severe OSA.¹⁴ In recent years, treatment of snoring and OSA with oral snore-reduction appliances occupied a firm place within the accepted therapeutic approaches to the problem. Appliances are regarded as effective solutions both medically and esthetically. For this reason, the role of the dentist has become crucial in providing an effective therapeutic option. Trained dentists can offer a solution to this medical problem and expand the arsenal of treatments that can be offered to suffering patients. In the current article, we examine the causes of OSA as well as the types of possible treatment, with an emphasis on treatment with oral appliances.

DATA SOURCES AND RESOURCES SELECTION

A comprehensive literature search of publications from 1934 to 2013 in the PubMed/Medline/Science Direct databases was performed to collect information about snoring, OSA, and dental or oral appliances using these terms as key words. The search was limited to peer-reviewed articles written in English with a few exceptions in other languages. The literature search was endorsed by manual searching through peer-reviewed journals and reference lists of the selected articles.

REVIEW

Pathophysiology of breathing during sleep

Sleep disorders such as snoring and OSA are predominantly based on muscular and skeletal peculiarities of the craniofacial structures of patients that inevitably or potentially lead to the upper airways narrowing. In such situations, there is increased resistance to air flow within retropalatal and retroglottal regions that potentially can cause their full block during inspiration. Soft tissue abnormalities, variations, or pathologic changes can also add to the narrowing of the respiratory tract. In turn, the increased resistance to air flow in the upper respiratory area can potentially lead to severe impairment of the surrounding muscles due to the constant additional pressure on them.^{6,7}

In children, factors predisposing to OSA are usually different from those in adults and include adenotonsillar hypertrophy, nasal obstruction, craniofacial disorders like Pierre Rubin syndrome, cleft palate, and obesity.¹⁵⁻¹⁸

Diagnosis of OSA

Diagnosis of snoring and OSA should be based on subjective and objective evaluations. Subjective evaluation primarily includes snoring during sleep and sleepiness during the day in adults.

Confirmation of existence and further monitoring of these symptoms can be achieved by using different questionnaires such as the Epworth Sleepiness Scale (ESS).¹⁹

In addition, the presence of obesity,^{20,21} decreased ability in mental concentration,²² headaches, and morning mouth dryness are also important parameters that help to establish the correct diagnosis. Polysomnography (PSG) is the best method to monitor and diagnose sleep apnea and other sleep-disordered breathing problems. PSG is a comprehensive recording of the biophysiological changes that occur during sleep. It is usually performed in a sleep laboratory or the patient's home using a portable device. PSGs are usually performed using four to eight channels measuring the nasal airflow, thoracic effort channels, electrocardiography (ECG), pulse oximetry, electroencephalography (EEG), electrooculography (EOG), electromyography (EMG),



sleep positioning, and leg movements. The main outcome of a PSG test is the AHI, which represents the sleep apnea severity and reflects the average number of apnea (complete cessation in air flow) and hypopnea (partial cessation in air flow) per hour of sleep. Newer tests provide similar information by measuring alterations in autonomic nervous system using a hand glove.²³

The severity of OSA is classified by the American Sleep Disorder Association (1999)²⁴ on the basis of patient's AHI into the following categories. In adults:

- Mild OSA, 5 to 15 AHI
- Moderate OSA, 15 to 30 AHI
- Severe OSA, more than 30 AHI.

These criteria are different for children:

- Mild OSA, 1 to 5 AHI
- Moderate OSA, 5 to 10 AHI
- Severe OSA, more than 10 AHI.

Risk factors for OSA are well known and include high body mass index (BMI),^{20,21} age,²⁵ male gender,²⁶ smoking,²⁷ craniofacial anomalies like micrognathia and retrognathia,^{28,29} alcohol consumption,³⁰ enlarged palatine tonsils, enlarged uvula, high-arched palate, nasal septum deviation, inferiorly displaced hyoid bone, disproportionately large tongue, a long soft palate, and general decreased posterior airway space.^{31,32}

Treatment of snoring and OSA

Following the diagnosis of OSA, it should be treated promptly. OSA in adults is evaluated as a chronic disorder and the treatment approaches are designed to minimize its outcomes. For this reason, the treatment includes different approaches bringing together various professionals such as general practitioners, sleep medicine specialists, otorhinolaryngologists, head and neck surgeons, nutrition experts, and dentists. Treatment depends in part on the severity of OSA and the clinical evaluation of the patient habits and upper airway anatomy. Therefore treatment should be tailored specifically to each patient.

Treatments for OSA include behavioral measures, devices, and surgical approaches.



Fig 1 A nasal CPAP mask, the treatment of choice in severe OSA.

General and behavioral measures

Behavioral modifications include: weight loss,^{33,34} avoiding sleep in the supine position,³⁵ cessation of smoking, avoiding alcohol before going to bed, proper treatment of lung diseases if any, minimizing the use of sleeping pills,³⁶ and improvement of nasal breathing.³⁷ If these measures do not bring the desirable results, specific snoring and OSA reducing devices are to be suggested.

Devices that provide positive air pressure during sleep:

- a continuous positive airway pressure (CPAP; automatic self-adjusting or fixed) device is a pump that increases air pressure in the upper airway and prevents the typical collapse of the lateral wall soft tissue and tongue base during sleep. CPAP machines are connected to different kinds of masks that cover the nose, can fit directly to the nostrils, or cover the nose and mouth in some cases (Fig 1).
- a bilevel positive airway pressure (BPAP) device is a noninvasive ventilation device that differs from the CPAP in being able to secure both inspiratory positive airway pressure (IPAP) and expiratory positive airway pressure (EPAP).

These forms of treatments are considered to be the most effective in reducing AHI.¹⁴ CPAP has been proven to reduce OSA symptoms such as fatigue and daily



sleepiness, decline in quality of life, and cardiovascular morbidity.^{8,38-40} However, numerous patients are unable or refuse to tolerate CPAP and the compliance is considered to be low.^{41,42} Moreover, patients with mild severity of the disorder, as well as low daily fatigue level (low scoring on ESS) are even less responsive.⁴³

Surgical procedures

There are several surgical procedures acceptable for treating OSA that vary in complexity as well as in the postsurgical complications. Among the simplest surgical approaches using local anesthesia, especially for snorers or mild OSA only, are radiofrequency volumetric tissue reduction (RVTR), coblation palatoplasty, and the Pillar procedure.⁴⁴ Uvulopalatopharyngoplasty (UPPP) is an example of more complex surgery designed to remove throat soft tissue like tonsils, part of the uvula, and part of the soft palate in order to widen the upper airway.⁴⁵

For pediatric patients, surgery is effective and widely accepted. Tonsillectomy and adenoidectomy are considered as treatment of choice.^{46,47} Treatment of nasal obstruction has been shown to improve OSA.^{48,49} In some cases, measures like rapid maxillary expansion or maxillomandibular expansion help to reduce AHI levels.⁵⁰⁻⁵²

More complex surgeries with higher chances of success for the treatment of adult snoring and severe OSA include bimaxillary and orthognathic procedures which involve change in face and upper airway proportions, usually by permanent advancement of one or both jaws.⁵³

Oral appliances for snoring and OSA

Oral or dental appliances were already introduced at the beginning of the 20th century.⁵⁴ When interest in sleep apnea treatment grew, the oral appliances received a new stimulus for their further development.⁵⁵ In 1991, the Sleep Disorders Dental Society (SDDS) was established with the goal of training medical specialists to treat OSA patients professionally. This society soon became known as the American Academy of Dental Sleep Medicine (AADSM) and in 2002, it

became a part of the American Academy of Sleep Medicine (AASM). Currently, different types of oral appliances are being used worldwide.

Mandibular Repositioning Device (MRD) or Appliance (MRA)

The MRD or MRA is an oral removable appliance that is currently commonly used. Its mechanism is based on the protrusion of the mandible along with the base of the tongue during sleep thus increasing the pharyngeal space (Fig 2). In doing so, the soft palate is stabilized and the retropalatal space is extended. The impact of this approach on these areas can be seen through redistribution of the tension passed between the soft palate and the body of the genioglossus muscle toward the hyoid bone and the mandible.⁵⁶ This impact is extended towards the hypopharynx, the velopharynx, and the oropharynx. Combination of all these mechanisms prevents the narrowing of the upper respiratory airway, allowing free air flow and reducing the vibration of soft tissues within upper airway.^{57,58} These devices are tailored to the patient (Fig 3) and can be modified in terms of mandible position.

Tongue Retaining Device (TRD)

Based on the principle of pulling the tongue during sleep, the TRD uses a specifically designed tongue vacuum cup. This device is mostly used by edentulous patients.^{59,60}

Soft Palate Lifters (SPL)

SPLs are removable upper arch devices that adapt to the hard palatal and soft palatal mucosal surfaces and the lingual aspects of the maxillary teeth, and support the soft palate. They are considered less effective than other devices.⁶¹

Indications for oral appliance

Oral appliances were approved by the Food and Drug Administration (FDA) for cases of OSA and habitual snoring. According to the AASM guidelines of 2006,⁶² these appliances are evaluated as a possible treatment of adults with mild to moderate OSA or in severe cases

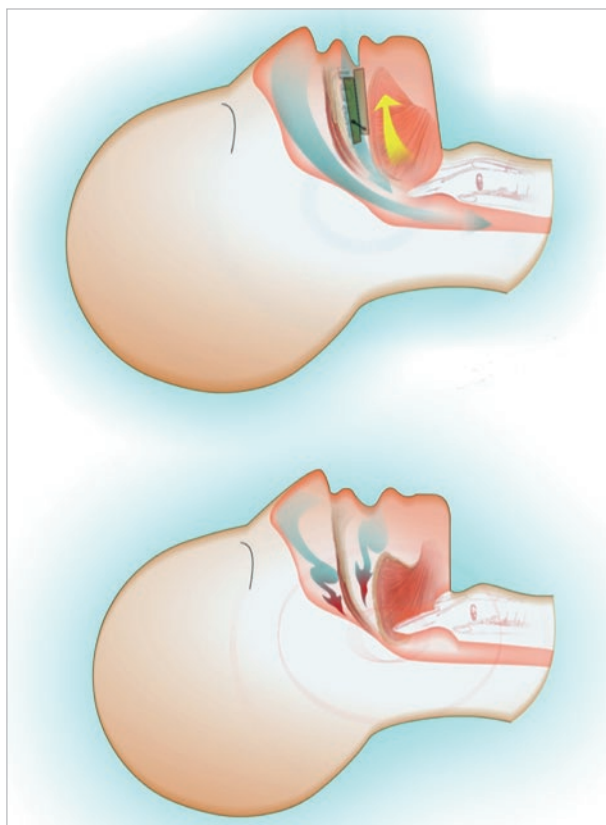


Fig 2 The sketch demonstrates the effect of an oral appliance on the upper airway (above), compared to an apnea episode that blocks the upper airway (below).



Fig 3 Oral appliances: (a) medical dental sleep appliance (MDSA); (b) Herbst appliance.

if a patient refuses or could not tolerate CPAP therapy. Oral appliances have proven efficacy in all of these parameters.⁶³⁻⁷⁰

The success rate of oral appliance therapy depends on several factors,⁷¹⁻⁷³ including OSA mild to moderate severity compared to severe,^{74,75} low BMI compared to a BMI over 30,⁷⁶ and young age.^{62,68,77}

Patient anatomical characteristics like large tongue, wide neck, and long palate decrease the chance of success.^{77,78} It was reported that oral appliances are more effective in managing sleep disorders in patients with retrognathism.⁷⁹ The type of device is also a significant factor of success, especially when comparing preferable custom-made versus “boil and bite” oral appliances.⁸⁰⁻⁸²

It is widely accepted that CPAP is superior to oral appliances in reducing AHI levels.^{63-65,68} However, oral appliances are usually considered to be easier to adjust

to than CPAP.^{41-43,64,65,80,83,84} The recent article by Phillips et al⁸⁵ indicates a similar health outcome when comparing CPAP to an oral appliance after 1 month of therapy, and revealed higher compliance rates of patients using the oral appliance.⁸⁵

Comparison between oral appliances and accepted surgical intervention like UPPP indicates that the appliances are twice as effective.^{86,87}

Side effects

In general, oral appliances are considered safe, and relatively minor side effects can be observed.⁸⁸ The major side effects include orthodontic changes associated with mandibular protrusion that may result in decrease of overbite and overjet with long-term use,^{89,90} and discomfort or even pain in mastication muscles and the temporomandibular joint.⁹¹

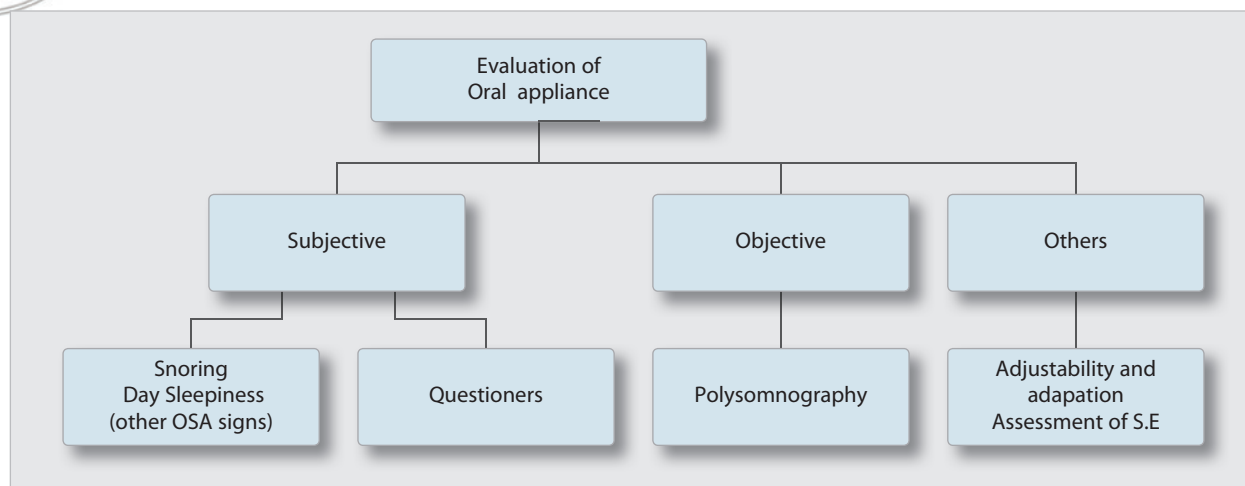


Fig 4 Flow chart demonstrating subjective and objective evaluation of oral appliance effectiveness. This combined evaluation is important for further adaptation/adjustment of the device for maximum efficacy and for monitoring side effects.

OSA in the dental setting

Children

Pediatric dental care is based on regular visits to a dentist. The role of the dentist in detecting OSA in children cannot be overestimated. Early recognition and prevention of OSA in children are very important in order to minimize and to prevent further complications. A dentist can identify a suspected OSA-suffering patient from early childhood to adulthood by detecting signs of the disease, and refer them to an ear, nose, and throat (ENT) physician or to a family doctor for further evaluation and treatment.

During examination, a dentist should pay attention to the following: poor ability to concentrate, poor school performance, failure to thrive, nose-breathing speech, poor appetite or overweight, recurrent airway infections, and significant various craniofacial and oral abnormalities like long narrow face, small chin, tooth crowding, and high-arched palate.^{17,92,93}

Early detection is important in children for normal mental and physical development.^{94,95} In the pediatric population with hyponasal hypertrophy, as mentioned before, a surgical approach is recommended (tonsillectomy, adenoidectomy).⁹⁶ Only in rare cases other therapeutic modalities are taken into account. It should be noted that treatment with a CPAP device at a young age can potentially lead to inadvertent skeletal changes.^{97,98}

Adults

In adults, dentists should suspect sleep apnea in obese patients, especially if they have craniofacial characteristics like retrognathism of the chin, wide size of the neck, a large tongue, and elongated palate that can easily be observed by a dentist or oromaxillary surgeon.^{99,100} In some patients with OSA, fatigue and sleepiness can be observed even during dental treatment, and low tolerance for pain,¹⁰¹ complaints of morning headaches,¹⁰² morning mouth dryness,¹⁰³ bruxism, and clenching¹⁰⁴ can indicate the possibility of OSA and the need for further attention.

The role of the dentist

Evaluation of a patient and selection of the most suitable oral appliance requires a comprehensive anamnesis and testing, checking for changes in general health, and examination of masticatory muscles and temporomandibular joints. Dental examination should ensure that at least five to ten teeth in the arch that might contact the appliance are healthy, and should include the evaluation of periodontal disease if any.

Precise evaluation of the efficiency of oral appliances is paramount to achieve optimal results. Inability to monitor a patient during sleep is a disadvantage, especially if compared to easily tested match standards for CPAP devices. Therefore, the dentist depends on

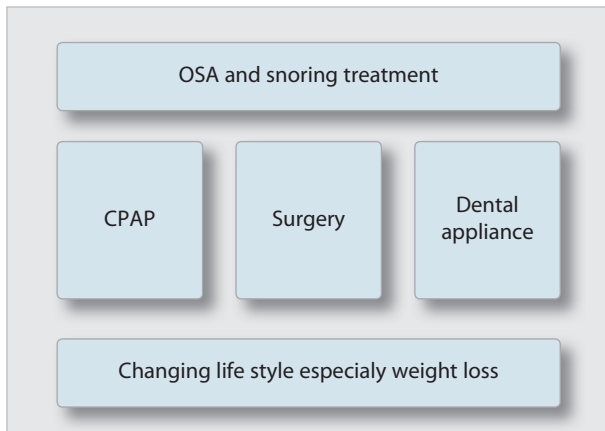


Fig 5 Treatment of snoring and OSA can be seen as a combined approach of several practitioners and treatment options: surgical treatment, CPAP usage, dental appliance therapy, and life style changes, particularly weight loss if necessary.

patients’ subjective appreciation and objective evaluation by following the sleep test (Fig 4). Testing of an appliance leads to its necessary adjustment, which takes into account its real and potential side effects.

The dentist needs to be part of a multidisciplinary team and communicate with other medical practitioners. Patients with OSA who are treated with oral appliances should return for follow-up visits with the dental specialist at regular intervals to monitor patient adherence, evaluate device efficacy, and to evaluate the health of the oral structures and integrity of the occlusion.^{62,77} Lack of understanding of these elements can lead to a lack of efficiency of the device and to potential damage. The patients must be well informed, which includes knowledge about treatment options including CPAP as well as chances of success and possible side effects and complications. Long follow-up is mandatory in order to evaluate the effectiveness of the device correctly and in order to detect possible side effects.

The usage of oral appliances can be combined either with CPAP or with surgical treatment in order to achieve the best results possible in treating the apnea (Fig 5).

In summary, the role of a dentist in the area of OSA is important both in diagnosis and in referral for further evaluation to other specialists. At the same time, the dentist can act as a provider of treatment in adults in

some cases. We regard the OSA-specific oral appliances as a good treatment that can succeed where other treatments have failed, and which could be offered as a first choice treatment for patients with snoring and mild to moderate OSA, or patients with severe OSA who do not tolerate CPAP therapy. General practitioners and dentists have to work in concord in order to provide the patient with the best treatment possible, tailored specifically to each individual patient.

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