Review Article

Dental Sleep Medicine

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ABSTRACT

Dental sleep medicine involves the use of oral appliances (OAs) designed to prevent retroglossal collapse in sleep-related breathing disorder (SRBD) in which there is partial or complete blockage of the airway during sleep. Although little or no air is flowing, the person continues to attempt to breathe. The cessations in breathing last for >10 s/episode, but can also last over a minute and frequently occur multiple times during sleep which leads to deprived sleep quality and a drop in blood oxygenation levels over a prolonged period. Dental sleep medicines involve various OAs include mandibular advancement devices, TRD, and membrane funnel oral shields. These devices are used primarily in patients with SRBD such as mild-to-moderate obstructive sleep apnea (OSA), continuous positive airway pressure (CPAP) intolerant OSA, and primary snorers. OA is preferred by patients as compared to CPAP even though they are partially effective. Although the effect is lesser as compared to CPAP, the improvement in sleepiness, blood pressure, and overall quality of life is similar. Dental sleep medicine offers a better treatment modality in patients with SRBD, as the primary treatment option.

Key words: Obstructive sleep apnea, sleep medicine, sleep-related disorder

INTRODUCTION

American Academy of Dental Sleep Medicine is defined (AADSM) as an area of dental practice that focuses on the use of intraoral appliance (OA) therapies to treat sleep-disordered breathing (SDB) such as snoring and obstructive sleep apnea (OSA).[1,2] In 2015, American Academy of Sleep Medicine collaborated with the AADSM to set a new standard for the use of dental services for both as an initial treatment modality and as an alternative treatment for SDB. OAs have advanced in the treatment of SDB as an increasingly prevalent alternative to more well-known therapies, including continuous positive airway pressure (CPAP).[3]

Common SDB conditions are snoring (most common), upper airway resistance syndrome, OSA, and bruxism. OSA, which the orthodontist will most frequently encounter, is considered part of a group of disorders called SDB. This class of disorders refers to abnormal respiratory patterns during sleep. It not only affects the quality of life but also has significant morbidity. The orthodontist may be called to screen for OSA, which contributes to the identification of underlying dentofacial components and assist the physician in managing the disease but OSA can only be ultimately diagnosed by a physician. Sleep apnea means "cessation of breath." It is usually demarcated as repetitive episodes of upper airway impediment that occurs during sleep and is generally associated with a reduction in blood oxygen saturation. Whereas, OSA is defined as either: More than 15 apneas, hypopneas, or respiratory effort related arousals per hour of sleep in an asymptomatic patient, or more than 5 apneas, hypopneas, or respiratory effort-related arousals (RERAs) per hour of sleep in a patient with symptoms, for example, sleepiness, fatigue, inattention, or signs of disturbed sleep, for example, snoring, restless sleep, and respiratory pauses. OSA syndrome applies only to the latter definition. In both situations, more than 75% of the apneas or hypopneas must have an obstructive pattern.

The history of the use of OAs dates back to Pierre Robin in 1902 who used a monobloc appliance to correct a breathing impairment during sleep caused by a pharyngeal obstruction in children with micrognathia and glossoptosis.[4] Various treatment options available for OSA include lifestyle changes, weight reduction, positive airway pressure, OAs, and pharyngeal surgeries. Dental sleep medicine involves the use of OAs for the management of mild-to-moderate cases of OSA and as an adjunct to positive airway pressure therapy.[5]

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TYPES OF SLEEP APNEA

There are three types of sleep apnea:

OSA

Most common type of sleep apnea occurs when "little" or "No" air is flowing but ventilator effort perseveres. It is caused by complete or nearly complete upper airway obstruction.

Central sleep apnea

Much less common occurs when both airflow and ventilator effort are absent. It involves the central nervous system brain fails to send the appropriate signals to the breathing muscles to initiate respirations. It may last a few seconds, with shallow breathing to provide oxygen to the blood and tissues, and may cause irregular heartbeat, high BP, heart attack, and stroke.

Mixed sleep apnea

It is a mix of intervals during which no respiratory efforts occur (i.e., central apnea pattern) and intervals during which obstructed respiratory efforts occur. Mixed apnea happens less often than obstructive apnea but more often than central and it should be treated as obstructive sleep apnea.

Diagnosis

The first step in the evaluation of cases with OSA includes a recording of a detailed history of the patient. Various predisposing factors are present that may cause breathing sleep disorder [Figure 1]. A detailed sleep history in a patient suspected of OSA should include an evaluation for snoring, gasping/choking episodes, excessive sleepiness, nocturia, morning headaches, sleep fragmentation/sleep maintenance insomnia, and decreased concentration and memory. Sleepiness in these cases is evaluated with the Epworth Sleepiness Scale.[6,7] Obesity is considered as a predisposing factor for OSA. Figure 2 enumerating the day and nighttime symptoms of OSA. A confirmative diagnosis of OSA is made with the help of polysomnography.[8,9] Polysomnography involves the recording of the chest and abdominal movements, oxyhemoglobin saturation, airflow, electrocardiogram tracing, sleep state (electroencephalogram, electrooculogram, and electromyogram), activity during sleep, and arousals. The severity of OSA is measured as the apnea-hypopnea index (AHI), with the number of episodes of apnea indicating the severity of the condition. Apnea is defined as a cessation of airflow for at least 10 s which may be obstructive or central based on the presence or absence of respiratory effort. Hypopnea is defined as a condition including one of three features: A substantial reduction in airflow (>50%), a moderate reduction in airflow (<50%) with desaturation (>3%), or moderate reduction in airflow (<50%) with electroencephalographic evidence of arousal.[10]

ROLE OF ORTHODONTIST/DENTIST

The primary care by the physicians may not always recognize the relationship between certain quiet signs of untreated sleep apnea or sleep breathing disorder. Here, the role of orthodontist or dentist comes into account these include clinical extraoral and intraoral evaluation, a routine examination technique such as lateral cephalograms for diagnosis by assessing the blockage as well as in treatment planning which can appreciate the skeletal factors responsible for sleep breathing disorder such as retrognathic mandible or maxilla, decreased throat angle, narrow dental arches, growth pattern usually vertical growth pattern associated with increased mandibular plane angle or obtuse gonial angle, and accentuated anti-gonial notch usually present in the patient suffering from mouth breathing habit. These patients also exhibit open bite tendency commonly treated which may be dental or skeletal.

Airway analysis is also an important diagnostic tool that can help to diagnose conditions such as enlarge lymphoid tissues, macroglossia, and constricted airway passage causing difficulty in breathing. In this way, the orthodontist/dentist can encounter the sleep breathing disorder and plan an important role in diagnosis and treatment with complaint OAs.[7]

OAs

The purpose of an OA is to treat OSA and associated symptoms. These dental appliances are indicated in mild-to-moderate cases of obstructive sleep apnea. Dental appliances are also suggested for patients who do not accept CPAP as the treatment modality. OAs are envisioned to decrease the frequency and duration of apnea's, hypopneas, respiratory effort-related arousals, and/or snoring events. OAs have been demonstrated to improve nocturnal oxygenation as well as the adverse health and social consequences of OSA and snoring. OA is typically used as the only mode of treatment for OSA, they can serve as an adjunct to PAP therapy and/or other treatment modalities for the management of OSA which are the ultimate treatment options.[11] These appliances allow the advancement of the mandible, thus allowing maintenance of a patent airway.

TYPES OF OAs

1. Mandibular advancement devices (MADs)
2. Tongue retaining devices (TRDs)
3. Combination CPAP/dental sleep device therapy.

The dentist chooses whether tongue repositioner/MAD is based on the following:

- Number of teeth present
- Status of temporomandibular joint (TMJ)
- Patient compliance.

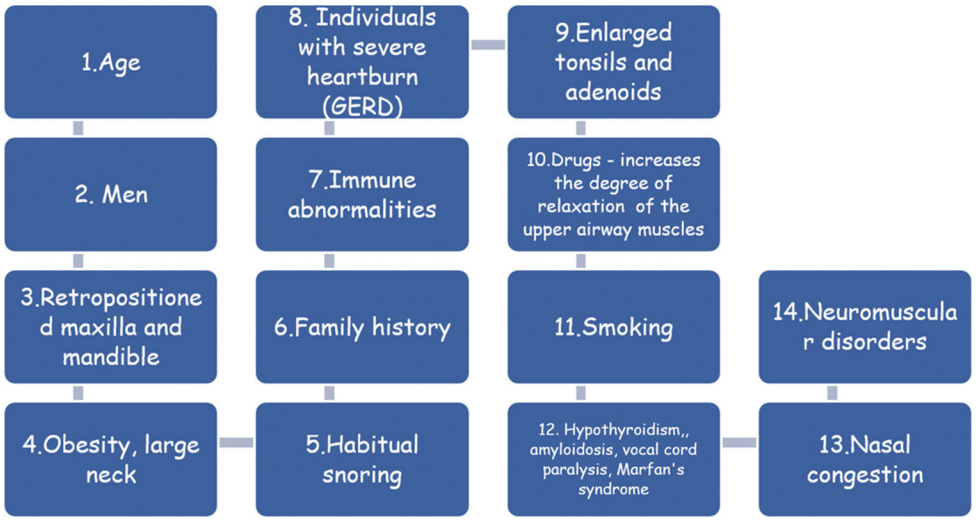

Figure 1: Predisposing factors causing breathing sleep disorder

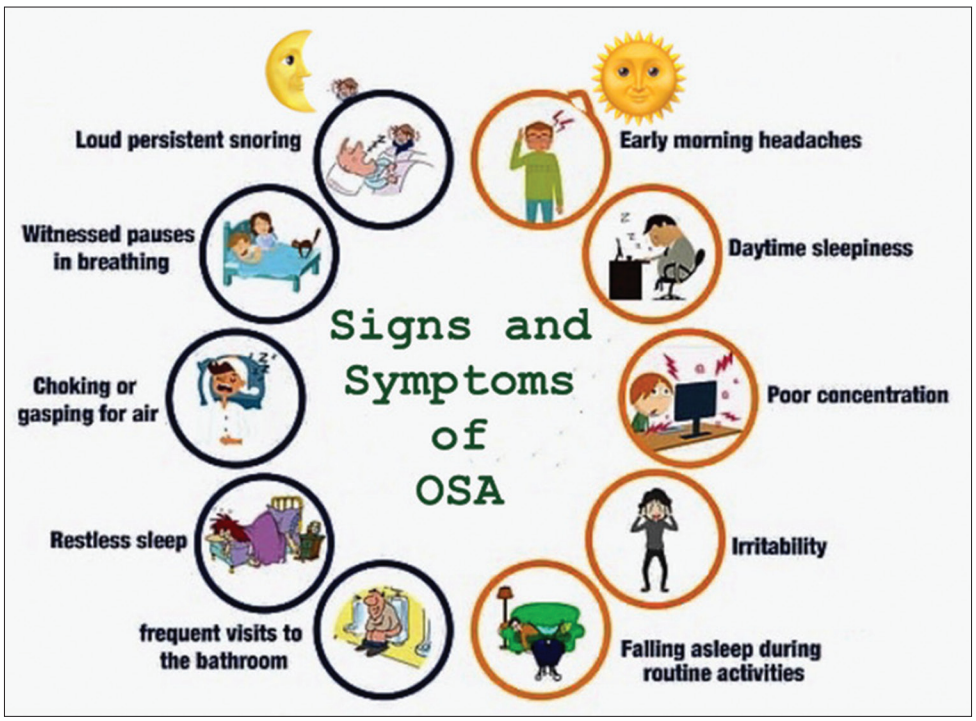

Figure 2: Signs and symptoms of sleep apnea

MADs

MADs are by far the most common type and have been a novel method for the management of snoring and OSA, for mild-to-moderate sleep apnea. A guideline published in the American Academy of Sleep Medicine in 1995 stated that MADs were indicated as first-line therapy for mild OSA and second-line therapy for moderate-to-severe type of OSA.[21] MAD works on the principle which encourages the proper positioning of the jaw, tongue, and other supporting structures related to the upper airway for the treatment of chronic snoring and OSA.[11,12]

Mechanism of MADs

These appliances carry out a forward and downward movement of the jaw, creating an anatomical variation in the upper airway that increases the pharyngeal area, this movement stabilizes and fixes the hyoid bone, the lower jaw, and the suprahyoid muscle, preventing the blockage of the upper airway.[13]

The degree of mandibular advancement is an important coordinator of the treatment outcome since there is a dose-dependent effect on oxygenation and pharyngeal collapse. A little advancement produces a less satisfactory effect, while too

large advancement produces more treatment effects as well as more side effects.[14] However, inappropriately large mandibular advancement should be avoided because of long-term negative side effects on occlusion and TMJ. There is currently no agreement regarding the method of measuring the degree of mandibular positioning. A titration procedure millimeter by millimeter has, therefore, been recommended to attain optimal results.[15,16]

Tongue repositioning devices (TRDs)

Tongue retaining devices (TRDs)

Tongue retaining devices (TRDs) were first described by Cartwright and Samelson[17] in 1982. TRDs are one type of OA used for the treatment of OSA.[18] It is a customized monobloc OA fabricated from a flexible polyvinyl material. It consists of a mouthpiece that entirely covers the arches of the maxilla and mandible, with a distinct mandibular advancement. It even holds the tongue forward due to the negative pressure created by air displacement from the lingual compartment of the appliance. The initial maximal mandibular protrusion is 50–75% but can be reduced if the patient complains of pain or discomfort and increased if the snoring remains unchanged after 3 weeks trial. The hole in the lateral side of the device facilitates mouth breathing. TRDs are the only appliance that can be used in the case of edentulism.

Deane *et al.*[19] reported that TRDs have a tendency similar to that of the MADs. Thus, a trained team of TRD fabrication and fitting may recommend it as an alternative to CPAP considering nasal obstruction as a contraindication.

Tongue stabilizing device (TSD)

It is a non-invasive anti-snoring device used in patients with OSA that suctions gently the tip of the tongue and then slightly braces on the lips or teeth to keep the tongue slightly forward thus, prevent it from falling back during sleep, which obstructs the upper airway. It is a preformed device made from soft medical grade silicone that is non-irritating to the gingiva, it is available in various sizes. As they are not reliant on teeth for retention, they have been proposed as an option for the patient with an absence of teeth (hypodontia and edentulism) or periodontal diseases. TSD is slightly different but is based on a similar implementation. Unlike MADs, it does not pull the entire mandible forward and is better suited for the patient who is not comfortable with the potential pressure on their teeth (exerted by MAD) and better for denture wearer.[20,21]

Deane *et al.*[19] did a comparative study between mandibular advancement splint (MAS) and TSD which showed comparable effectiveness in terms of apnea-hypopnea index reduction. Patients testified improvement with both the devices; however, improved compliance and a clear preference for MAS were apparent when both devices were given. Long-term studies are needed to clarify the role of TSD.

Combination CPAP/dental sleep device therapy

Combination therapy is a fairly new paradigm that is starting to gain more interest. The CPAP continues to be considered as a "gold standard" for the treatment of OSA, the problem associated with this therapy is due to high pressures and uncomfortable fit of the mask making its compliance rate low and masking its true effect. On the other hand, OA therapy enjoys a high compliance rate but may not be as effective as CPAP in parameters like oxygen desaturation index or AHI index in moderate-to-severe OSA cases.

The dentist and physician can work together to make the combination of dental sleep devices with CPAP a better option. This customized device or OA will attach directly to the CPAP machine.

If the CPAP is combined with the MADs, it should be used at a much lower pressure setting.[22]

EFFECTIVENESS OF OAs

Patients using OAs for the management of OSA reported increased usage of OAs and adequate control in snoring. Previously, controlled trials have detailed that OAs are effective for the treatment of OSA. These studies suggested a complete response (reduction of the AHI to 5 events/h) which can be expected in approximately 35–40% of patients and a partial response (50% reduction in AHI compared to baseline, but residual AHI remaining 5 events/h) in 25% of patients. Treatment failure occurs in approximately 35–40% of patients.[23,24]

The usage of MADs has been shown to improve nocturnal respiratory function and sleep quality in patients with OSA. Lee *et al.* reported a decrease in mean (SD) AHI significantly ($P < 0.001$) from 36.6 (18.9) to 12.3 (11.4). The success rate, defined by an AHI of lower than 20 and 50% decrease in AHI, was 74% (37 of 50 patients). Several studies have demonstrated a reduction in blood pressure after the use of OAs.[14] The effect of OA treatment on neuropsychological functioning has been examined in studies using inactive oral devices.

Adjustable devices produce a greater decrease in obstructive events and are more likely to produce successful therapy, especially in moderate-severe OSA.

Lettieri *et al.*[23] reported that obstructive events were reduced to < 5/h in 56.8% with adjustable compared to 47.0% with fixed appliances ($P = 0.02$). Fixed appliances were effective in mild OSA, but were less successful in those with higher AHIs. Reduction of events to <10 with the resolution of sleepiness occurred in 66.4% with adjustable appliances compared to 44.9% with fixed appliances ($P < 0.001$). Given these findings, the baseline AHI should be considered when selecting the type of OA.

Doff *et al.*[24] investigated that long-term use of an OA (OA) resulted in little but significant dental changes compared with CPAP. He reported that there was a decrease in overjet and overbite 1.5 (±1.5) mm and 1.2 (±1.1) mm, respectively, in the OA group. They even found a significantly larger anteroposterior change in the occlusion (−1.3 ± 1.5 mm) of the OA group compared to the CPAP group (−0.1 ± 0.6 mm). There was a significant decrease in occlusal contact points in the premolar and molar regions of both groups. Linear regression analysis showed that the decrease in overbite was associated with the mean mandibular protrusion during follow-up (regression coefficient [β] 0–0.02, 95% confidence interval [−0.04–−0.00]).

SIDE EFFECTS

OAs are associated with few side effects such as TMJ-related symptoms, bite changes, and unwanted tooth movement. Several other side effects associated with OAs included excessive salivation, gum irritation, tooth pain, mouth dryness, headaches, myofascial pain, and TMJ discomfort.[25] Dental appliances also resulted in changes in occlusion, reduction in overjet, changes in the inclination of incisors, increase in lower anterior facial height, and increase in mandibular plane angle.[26,27]

CONCLUSION

OAs that advance the mandible are gaining popularity for the treatment of OSA syndrome. This is because OAs provide a valuable alternative to the treatment of patients who cannot tolerate the standard therapy for OSA, that is, CPAP. Moreover, OA offers advantages over CPAP for travelers, who avoid the inconvenience of carrying heavy equipment, and for residents of areas, where electrical power is not available. In several randomized controlled trials, it has been found that OA improves the symptoms associated with OSA. Improvement in breathing and sleep disturbances was also seen when measured objectively.

REFERENCES

1. Gotsopoulos H, Darendeliler AM, Cistulli PA. Oral appliance therapy for obstructive sleep apnea. Treat Respir Med 2005;4:409-22.
2. Shepard JW. Hypertension, cardiac arrhythmias, myocardial infarction, and stroke in relation to obstructive sleep apnea. Clin Chest Med 1992;13:437-58.
3. Shahar E, Whitney CW, Redline S, Lee ET, Newman AB, Nieto FJ, *et al.* Sleep-disordered breathing and cardiovascular disease: A cross-sectional results of the Sleep heart health study. Am J Respir Crit Care Med 2001;163:19-25.
4. Nielsen IL. Guiding occlusal development with functional appliances. Aust Orthod J 1995;14:49-57.
5. Ferguson KA, Cartwright R, Rogers R, Schmidt-Nowara W. Oral appliances for snoring and obstructive sleep apnea: A review. Sleep 2006;29:244-62.
6. Marshall NS, Wong KK, Liu PY, Cullen SR, Knuiman MW, Grunstein RR. Sleep apnea as an independent risk factor for all-cause mortality: The Busselton health study. Sleep 2008;31:1079-85.
7. Quan SF, Schmidt-Nowara W. The role of dentists in the diagnosis and treatment of obstructive sleep apnea: Consensus and controversy. J Clin Sleep Med 2017;13:1117-9.
8. Marcus CL, Brooks LJ, Draper KA, Gozal D, Halbower AC, Jones J, *et al.* Diagnosis and management of childhood obstructive sleep apnea syndrome. Pediatrics 2012;130:e714-55.
9. Wali SO, Abalkhail B, Krayem A. Prevalence and risk factors of obstructive sleep apnea syndrome in a Saudi Arabian population. Ann Thorac Med 2017;12:88-94.
10. Reddy EV, Kadhiravan T, Mishra HK, Sreenivas V, Handa KK, Sinha S, *et al.* Prevalence and risk factors of obstructive sleep apnea among middle-aged urban Indians: A community-based study. Sleep Med 2009;10:913-8.
11. Ramar K, Dort LC, Katz SG, Lettieri CJ, Harrod CG, Thomas SM, *et al.* Clinical practice guideline for the treatment of obstructive sleep apnea and snoring with oral appliance therapy: An update for 2015. J Clin Sleep Med 2015;11:773-827.
12. Doff MH, Hoekema A, Wijkstra PJ, van der Hoeven JH, Slater JJ, de Bont LG, *et al.* Oral appliance versus continuous positive airway pressure in obstructive sleep apnea syndrome: A 2-year follow-up. Sleep 2013;36:1289-96.
13. Jayesh SR, Bhat WM. Mandibular advancement device for obstructive sleep apnea: An overview. J Pharm Bioallied Sci 2015;7 Suppl 1:S223-5.
14. Cobo JM, de Carlos F, Suarez AA. Mandibular advancement device (MAD®) to treat sleep apnoea-hypopnoea syndrome and chronic snoring: 25th Southern biomedical engineering conference 2009. IFMBE Proc 2009;24:349-54.
15. Isono S, Tanaka A, Sho Y, Konno A, Nishino T. Advancement of the mandible improves velopharyngeal airway patency. J Appl Physiol (1985) 1995;79:2132-8.
16. Fleury B, Rakotonanahary D, Petelle B, Vincent G, Fleury NP, Meyer B, *et al.* Mandibular advancement titration for obstructive sleep apnea: Optimization of the procedure by combining clinical and oximetric parameters. Chest 2004;125:1761-7.
17. Cartwright RD, Samelson CF. The effects of a nonsurgical treatment for obstructive sleep apnea. The tongue-retaining device. JAMA 1982;248:705-9.
18. Sutherland K, Deane SA, Chan AS, Schwab RJ, Ng AT, Darendeliler MA, *et al.* Comparative effects of two oral appliances on upper airway structure in obstructive sleep apnea. Sleep 2011;34:469-77.
19. Deane SA, Cistulli PA, Ng AT, Zeng B, Petocz P, Darendeliler MA. Comparison of mandibular advancement splint and tongue stabilizing device in obstructive sleep apnea: A randomized controlled trial. Sleep 2009;32:648-53.
20. Gotsopoulos H, Chen C, Qian J, Cistulli PA. Oral appliance therapy improves symptoms in obstructive sleep apnea: A randomized, controlled trial. Am J Respir Crit Care Med 2002;166:743-8.
21. Mehta A, Qian J, Petocz P, Darendeliler MA, Cistulli PA. A randomized, controlled study of a mandibular advancement splint for obstructive sleep apnea. Am J Respir Crit Care Med 2001;163:1457-61.
22. Church GD. The role of polysomnography in diagnosing and treating obstructive sleep apnea in pediatric patients. Curr Probl Pediatr Adolesc Health Care 2012;42:2-25.
23. Lettieri CJ, Paolino N, Eliasson AH, Shah AA, Holley AB. Comparison of adjustable and fixed oral appliances for the treatment of obstructive sleep apnea. J Clin Sleep Med 2011;7:439-45.
24. Doff MH, Finnema KJ, Hoekema A, Wijkstra PJ, de Bont LG, Stegenga B. Long-term oral appliance therapy in obstructive sleep apnea syndrome: A controlled study on dental side effects. Clin Oral Investig 2013;17:475-82.
25. de Almeida FR, Lowe AA, Tsuiki S, Otsuka R, Wong M, Fastlicht S, *et al.* Long-term compliance and side effects of oral appliances used for the treatment of snoring and obstructive sleep apnea syndrome. J Clin Sleep Med 2005;1:143-52.
26. Ahrens A, McGrath C, Hägg U. A systematic review of the efficacy of oral appliance design in the management of obstructive sleep apnoea. Eur J Orthod 2011;33:318-24.
27. Dioguardi A, Al-Halawani M. Oral appliances in obstructive sleep apnea. Otolaryngol Clin North Am 2016;49:1343-57.