

Obstructive Sleep Apnea: Prosthodontists View

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ABSTRACT

Background: Sleep being a fascinating aspect of life is important for relaxation and also for decisive influence on neuronal regenerative processes, behavioural patterns, and metabolic recovery through physiologic and cognitive factors. Prosthodontists have a significant role in diagnosis, management and care of patients suffering from Sleep Apnoea (SA). Oral appliances (OA) are simpler alternative to Continuous Positive Airway Pressure (CPAP). It is a non-surgical management which is quite simple, portable, economical and do not require a power source. It is the first line of treatment in almost all patients having Obstructive Sleep Apnea (OSA). The simplicity and cost makes its use applicable to a wide range of patients for the potential preservation of oral structures.

Keywords: Sleep apnea (SA), Obstructive sleep apnea (OSA), Oral Appliances, Mandible Repositioning Appliances (MRA), Tongue Retention Devices (TRD).

INTRODUCTION

Sleep-disordered breathing refers to momentary, often cyclical, cessations in breathing rhythm (apneas) or momentary or sustained reductions in the breath amplitude (hypopneas), sufficient to cause significant arterial hypoxemia and hypercapnia¹. Sleep apnea (SA) is a common disorder that pauses your breath from a few seconds to minutes or get very shallow which may occur 30 times or more in an hour. In the most common form, this follows loud snoring, choking or snorting sound as breathing resumes. This disrupts normal sleep therefore those affected are often sleepy or tired during the day². These apneas and hypopneas are specific to the sleeping state and are accompanied by: a compromised, often even completely closed, extra thoracic upper airway Obstructive (i.e.OSA), a marked reduction or cessation of brain stem respiratory motor output Central (i.e.CSA), and a combination of the two

called mixed. The most common type is obstructive sleep apnea (OSA)¹. SA can be serious, life threatening condition therefore treating it is essential. Gold standard for SA treatment is Continuous Positive Airway Pressure (CPAP). Though CPAP is still considered the most efficacious treatment many patients find this form of treatment uncomfortable or intolerable, making an oral appliance (OA) often found to be a more appropriate option³. George Cattlin was probably the first person who seriously thought that the route of breathing may influence sleep quality and daytime function. However, modern published clinical work begins in 1903, when Pierre Robin first described a device, called the “monoblock”, for the treatment of glossoptosis. More than 30 years later, he used an OA to reposition the mandible⁴.

OA offer a safe, effective and non-invasive treatment option for those suffering from OSA and severe, chronic snoring. When utilized during sleep, they

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help maintain an open and unobstructed airway in the throat by repositioning or stabilizing the lower jaw, tongue, soft palate or uvula. There are many types of OA, with some designed specifically for snoring and others intended to treat both snoring and SA. They are often considered by patients to be a more acceptable treatment modality compared to CPAP, as they are quiet, portable, economical and do not require a power source⁶.

Pathophysiology and Types of Sleep Apnea

SA, also spelled **sleep apnoea**, is a sleep disorder characterized by pauses in breathing or instances of shallow breathing during sleep. Each pause, called apnea, can last for a few seconds to several minutes. For a diagnosis of SA, more than five episodes an hour must occur. SA is classified as a dyssomnia. When breathing is paused, carbon dioxide builds up in the bloodstream. Chemoreceptors in the blood stream note the high carbon dioxide levels. The brain is signaled to wake the person sleeping and breathe in air. Breathing normally will restore oxygen levels and the person will fall asleep again. SA is often diagnosed with an overnight sleep test called a **polysomnogram**, or "sleep study" & several such studies demonstrate that between 2 and 4% of middle aged adults have clinically significant SA with a male: female ratio of 2:1.⁷

Based on the frequency of occurrence, SA can be classified into three main type (based on the cause of apnoea)⁸:

A) OBSTRUCTIVE SLEEP APNOEA (OSA): The **obstructive sleep apnoea-hypopnoea (OSAH) syndrome** is defined as a patient suffering five or more apnoeas/ hypopnoeas per hour of sleep with daytime symptoms.⁹ However, it is believed that only about 10% of people with OSA seek treatment. Clinically, OSA is defined by the occurrence of daytime sleepiness, loud snoring, witnessed breathing interruptions, or awakenings due to gasping or choking in the presence of at least 5 obstructive respiratory events per hour of sleep.¹⁰ The site of obstruction is located in the pharynx and the structures involved are the same as those responsible for snoring. During sleep, a person's throat muscles relax allowing the tongue and/or fatty tissues of the throat to fall back into the airways and block airflow. During

an apnea event air is restricted from moving beyond the obstruction reducing blood flow to the brain. This in turn signals the brain to partially awaken from sleep to signal the body that it needs to breathe. This is often followed by a loud gasping, choking, or snorting sounds as the person takes a deep enough breath to fight past the obstruction. Once a breath is taken the brain returns to sleep, and the process begins once again.¹¹ Weight, age, gender, neck position and diameter, retropositioned maxilla and mandible, enlarged tonsils or adenoids, habitual snoring, smoking, systemic illness are major risk factors¹²⁻¹⁴.

B) CENTRAL SLEEP APNEA (CSA): It occurs when the brain temporarily fails to signal the muscles responsible for controlling breathing. CSA is often caused by medical problems and conditions that affect the brainstem¹⁵.

C) MIXED SLEEP APNEA/ COMPLEX SLEEP APNEA: Mixed SA is a combination of both obstructive and central sleep apnea symptoms. Some patients being treated for obstructive sleep apnea with the use of CPAP machines develop symptoms of central sleep apnea upon PAP therapy¹⁵.

DIAGNOSIS:

The diagnosis of OSA starts with a sleep history that is typically obtained in one of three settings: first, as part of routine health maintenance evaluation, second, as part of an evaluation of symptoms of OSA, and third, as part of the comprehensive evaluation of patients at high risk for OSA. Questionnaire¹⁶ should aim to include a history of snoring and daytime sleepiness and an evaluation for the presence of obesity, retrognathia, or hypertension.

TREATMENT

Although CPAP is clearly more effective than any devices, especially for severe disease, OA also have a role in treatment of OSA. Patients with mild to moderate OSA are candidates for placement of appropriate oral devices¹⁷. Dental appliances may prevent snoring and OSA by modifying the position of the upper airway structures so as to enlarge and/or reduce collapsibility of the airway. The use

of intra-oral appliances is simple, non-invasive, reversible and cost-effective and may be the basis of definitive lifelong treatment.

There are three concepts for OA to modify the airway which can be used alone or in combination depending on where the airway obstruction occurred:

- a) Soft palate lifting appliance
- b) Tongue retention and
- c) Mandibular repositioning¹⁸.

1) Soft Palate Lifting: Many patients have excessive tissue in the oral pharyngeal region that obstructs the airway and causes snoring. The Palatal Lift appliance has an adjustable acrylic button that extends distally to the midpoint of the soft palate and gently lifts this tissue, preventing it from vibrating as air passes during sleep. The prosthesis lifts and/or stabilizes the soft palate, preventing vibration during sleep. An impression is made with irreversible hydrocolloid, with a posterior extension to the soft palate. The appliance is made with heat processed poly methyl methacrylate (PMMA) resin after incorporation of retentive elements. The tissue surface of the soft palate extension part is relined with soft liner and the appliance placed in the mouth. This appliance can be used in cases where incompetency of the soft palate is the cause for snoring, as it enables lifting of the soft palate¹⁹. The soft palate lifting appliances have a limited applicability in patients exhibiting exaggerated gag reflex due to the contact of the appliance with the soft palate and uvula. The soft palate lifting design is not often used because of patient tolerance and the fact that tongue posture rather than soft palate position is considered to have a significant influence on the patency of the upper airway. An appliance similar to the soft palate lift appliance can also be fabricated called the *Uvula lift appliance*²⁰. This appliance can be used in patients with elongated or bifid uvula which is the cause for upper airway obstruction. Irreversible hydrocolloid impression of the maxillary arch is made with a posterior extension up to the uvula by a stainless stock tray, which is extended posteriorly, with extra-hard base plate wax. It is fabricated with the help of the compression moulding technique, and retentive clasps which will aid in retaining the

appliance intraorally. The appliance is placed in the oral cavity and the tissue surface of the uvula extension part of the appliance is relined with a soft liner. The appliance is placed in the mouth and examined for the position of the uvula lift extension and patient comfort¹⁷.

2) Tongue Retention devices (TRDs): It was first designed in 1982 which consists of a mouthpiece that covers the entire upper and lower dental arches, with a defined mandibular protrusion. It pulls the tongue slightly forward due to the negative pressure created by the displacement of air from the lingual compartment of the device. The TRD is custom made from casts of the tongue and teeth using a soft copolymer. The initial mandibular protrusion is 50% to 75% of maximal protrusion. This protrusion distance is reduced if the patient complains of pain and is increased if snoring remains unchanged. TRDs incorporate an anterior hollow bulb, which generates a negative pressure vacuum when the tongue is inserted. The tongue is held forward away from the posterior pharyngeal wall opening up the airway. Owing to muscle anatomy, this appliance simultaneously modifies the position of the mandible. Lateral holes facilitate mouth breathing. This appliance is suitable in case of edentulism²¹. TRD are currently seldom used, being completely replaced by Mandibular Advancement Appliance (MAA).

- **Aveo TSD (TONGUE STABILIZING DEVICE)**

It was developed following several years of clinical research in the treatment of SNORING and OSA. The aveoTSD is made from a soft medical silicone for comfort and works by holding the tongue forward by gentle suction preventing it from falling back against the back of the throat, keeping the airway open during sleep. It does not attach to the teeth. It is a non-adjustable universal device that is the most cost effective and simple to use. It consist of a narrowed isthmus which extend intraorally to incorporate the incisor teeth or in edentulous patients, the alveolar ridge. This isthmus is joined anteriorly to a bulbous compartment. The tip of the tongue is inserted into the bulbous compartment, which contain vertical supports to hold the tongue in a forward position by negative pressure.

Approved by the F.D.A in the U.S.A as a medical device.²²

- **Full Breath Appliance**

The design of the Full Breath Solution focuses on inhibition of tongue movement; inhibiting the rise and backward movement of the tongue so that it does not block the airway during sleep. With a single arch appliance designed to provide subtle yet effective adjustments, the Full Breath Solution improves airflow 100% of the time and stops snoring with 95% of all patients²³.

- **Nose Breathe Appliance**

The Nose Breathe for Heavy Snorer is a new tongue-retaining oral appliance. The tongue is held at the roof of the mouth and retained by a naturally occurring lip seal and tongue suction due to the negative pressure of the oral cavity. It is an anatomical feature of the human oral cavity, only found during nasal breathing. The breathing/swallowing/tongue placement mechanism must function synergistically for normal esophageal peristalsis activity, as well as for the normal cranio-facial development. If not, problems, such as, acid reflux, aspiration, COPD, crooked teeth, aerophagia, dysphagia, diabetes, asthma, bed wetting could result. The biggest culprit is the tongue activity during swallowing. Nasal breathing is the most effective way to control the aberrant tongue function. Nasal breathing/swallowing/tongue placement must be looked as a unit and not as separate functions. The Nose Breathe for Heavy Snorer is constructed of EVA (ethyl vinyl acetate) material, and is very comfortable. Upper and lower impressions are required and are custom-fitted. The bite is set in the normal occlusion. There is no pressure on the TMJ, and thereby, it will prevent permanent bite shift from occurring. The nasal breathing can effectively control snoring and mild sleep apnea. The early control of snoring and mild sleep apnea is important because recent studies are showing that within six years heavy snoring could lead to high blood pressure, stroke and OSA.²⁴

3) Mandible Repositioning Appliance (MRD):

They are also called Mandibular Repositioners, protruders, devices, splints, prosthesis etc. MRDs

enlarge the upper airway during sleep by holding the mandible in a forward position i.e; antero-inferior position, which indirectly brings the tongue forward opening up the posterior airway. The repositioning may also stretch and reduce the collapsibility of the soft palate via its connection to the base of the tongue and increase the superior airway space. Appliances for the treatment of snoring and OSA have been described with different degrees of horizontal and vertical repositioning of the mandible. The most common mandibular repositioning dimension quoted is 50–75% of maximal protrusion (approximately 5–7 mm) with minimal vertical opening. The rationale for minimal opening is that, as the mandible opens, it rotates in an inferior and posterior direction²⁵.

- **Elastic Mandibular Advancement Appliance (EMA)**

Custom appliance is a simple, patient-friendly oral appliance created for non-invasive treatment of snoring and OSA. The primary treatment mechanism of opening the bite and gently moving the mandible forward is achieved with the use of interchangeable elastic straps that offer varying degrees of mandibular advancement. The flexibility of these elastic straps provides unsurpassed lateral movement and overall TMJ comfort.

- **Elastomeric Sleep Appliance**

Constructed in a dental laboratory, it is made of a very pliable soft, custom-injected silicone and is tooth retained. There are no clasps or wires to adjust. The flexibility of the material lends itself to a high degree of patient comfort. The Elastomeric appliance is not protrusively adjustable. The vertical opening is 5 mm and the mandible is afforded some limited movement due to the high flexibility of the material. Recommended for partially edentulous patients and non-bruxers²⁶.

- **Herbst Telescopic Appliance**

The Herbst Appliance has been proven to be effective on chronic snoring and mild to moderate OSA. This appliance allows patients to move laterally and vertically without disengaging the appliance. Also, if it is determined that the initial position does not provide the anticipated relief of the condition, the mandible can easily be moved

forward by two options of adjustability. The first option is traditional hardware with sets of 1, 2 and 3 mm shims for advancing those increments only. The second being the Telescopic version allowing the clinician to advance in ¼ mm increments by making one full turn of the protrusion collar up to 6-8mm from the start position. The appliance can be fabricated from hard acrylic, thermoactive and soft materials and is tooth retained via friction grip or clasps. The Herbst Appliance is a mandibular repositioner that has been in use many years for orthodontic and TMJ therapy prior to its modification for treatment of sleep disordered breathing. The greatest advantage of the Herbst appliance is that it allows for very quick, easy and accurate mandibular protrusive adjustability. This is accomplished through simple manipulation of the rod/sleeve plunger mechanism. Vertical opening varies is 5 mm and there is limited freedom of movement for the mandible in a lateral direction. Bilateral interarch elastics are recommended to keep the jaw closed during sleep²⁷.

- **Hilsen Adjustable Appliance**

The appliance is constructed of maxillary and mandibular full arch thermoplastic bases with Velcro-like attachments on the occlusal surfaces of both. It is retained by friction grip to the teeth. These provide simple and easy adjustment antero-posterior and left and right over a wide range. Adjustments are easily accomplished by the doctor or patient²⁸.

- **Klearway TM oral appliance**

It is a fully-adjustable oral appliance with a maxillary orthodontic expander to sequentially move the mandible forward. It is used for the treatment of snoring and mild to moderate OSA. The appliance is fabricated of thermoactive acrylic, becomes pliable for easy insertion and confirms securely to the dentition for an excellent fit while significantly decreasing soft tissue and tooth discomfort. Small increments (0.25 mm) of forward lower jaw advancement are initiated by the patient under the direction of a dentist and this helps avoid rapid jaw movements that can cause significant patient discomfort. Once warmed under hot water and inserted, the acrylic resin hardens as it cools to body temperature and firmly affixes itself to both arches. Lateral and vertical jaw movement is

permitted which enables the patient to yawn, swallow, and drink water without dislodging the appliance²⁹.

- **Lamberg Sleep Well Device (LSWD)**

The LSWD is a mandibular advancement device. It is inserted in the mouth and fits on the palate like a retainer. It has a protrusive element which rests behind the lower anterior teeth to maintain them in a comfortable forward position. This allows the lower jaw to move freely from side to side as well as open slightly. The appliance will be dispensed with a suck down for lower anteriors which can be used as necessary. The protrusive element will extend downward approximately 10mm and thus prevent the lower teeth from disengaging it. Most unique is the feature that there is an anterior stop (no material on the posterior teeth) which serves to minimize clenching. Since clenching is a necessary component of bruxing, it will reduce bruxing as well. The patent is pending and it is FDA accepted for snoring.³⁰

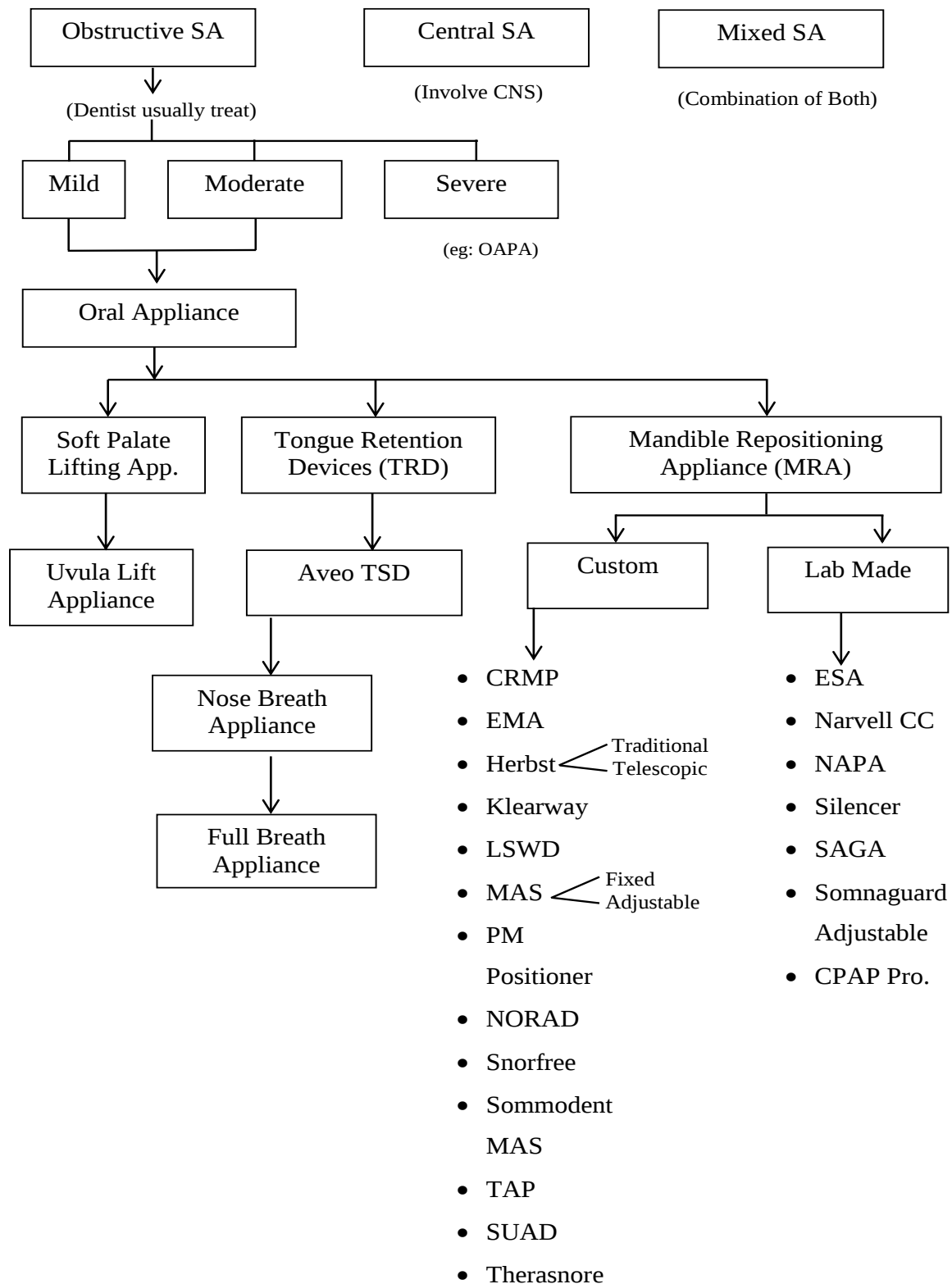
- **Mandibular advancement splints (mas)**

MAS is sometimes prescribed for mild or moderate sufferers. It is designed to hold the lower jaw slightly down and forward relative to the natural, relaxed position. This position holds the tongue farther away from the back of the airway, and may be enough to relieve apnea or improve breathing for some patients. This is available in either a fixed type or an adjustable type. The adjustable type has a higher success rate than the fixed type. Because the adjustments are made slowly, it can be easier to get used to & only temporary pain in the jaw. A sleep test may be needed to find out if the appliance helps³¹.

- **Mandibular Inclined Repositioning Appliance (MIRS)**

An open airway is maintained with this appliance by directly holding the mandible in a downward and toward position with an incline flange. This flange is made out of a thermoplastic material that softens at body temperature keeping it comfortable for the patient. The body of the appliance is made out of hard acrylic and snap fits to the upper arch. The lower dentition is deeply indexed into the occlusal surface of the appliance to hold the mandible in the

SLEEP APNEA (SA)



forward position. A breathing hole is placed in the anterior portion of the appliance to allow for easy breathing throughout the night.

- **Medical dental Sleep Appliance (MDSA)**

It is a titratable MAA with the:

- ~ Ability to adjust the advancement when the appliance is in place using a key
- ~ Lateral movement of the mandible with the appliance in place reduces TMJ problems and improves comfort
- ~ Low profile of the appliance allows minimum opening of the bite³⁰.

- **Narval CC sleep apnea oral appliance**

This device is a new generation custom-made mandibular repositioning device with patented physiological articulation and unique comfortable splints to optimize patient acceptance and treatment efficacy³². In March 2009, Narval launched this mandibular repositioning device using the Narval CAD/CAM Technology (Computer Aided-Design and Computer Aided Manufacturing) by laser sintering a polymer powder. The CAD/CAM Technology offers more customization possibilities for the device and a greater mechanical strength. It has shown clinical success results on 108 patients with OSAS and obstructive snoring with efficacy of more than 80% in treating snoring. An average decrease of 60% of sleep disruptions and respiratory events during sleep and improving the quality of life and sleepiness decreasing of more than 25% of the Epworth sleepiness score.

- **TAP (Thornton Adjustable Positioner)³³**

TAP is a custom-made two piece adjustable appliance that is worn while sleeping. The trays of the appliance snap over the upper and lower teeth and hook together. The design is based on the same principle as cardiopulmonary resuscitation (CPR). The airway must be opened to allow air to pass through the throat. The TAP holds the lower jaw in a forward position so that it does not shift nor fall open during the night. This prevents the airway from collapsing. The more you pull your jaw forward, the more your airway will open.

The TAP is the only mandibular advancement device that can be adjusted easily by the patient or

practitioner while in the mouth. This feature allows the patient to always be in control of their treatment. The unique design also allows the patient to fine-tune their treatment position at home to achieve maximum results.

Most patients experience relief the very first night they wear their TAP. Although it may take up to a week to get used to wearing a TAP appliance, this is a small hurdle for patients. Nine in ten patients wear the device all night, every night making the TAP a highly effective solution for both snoring and sleep apnea. It has shown superior results as it is patient friendly, easy to fit, infinitely adjustable, precise control of advancement, interchangeable hooks, freedom for lateral movement gives more room for tongue and allows lips to close.

- **SomnoDent MAS³³**

Continuous Open Airway Therapy (COAT) – is SomnoMed's oral appliance for sleep apnea. The SomnoDent MAS is a custom-made device, consisting of upper and lower dental plates with a unique patented fin-coupling component, which allows normal mouth opening and closing. If required, a part can be added to make the device adjustable. This feature provides incremental and adjustable levels of lower jaw advancement, which improves the effectiveness and comfort-level of treatment as the jaw is moved only as far as is required to alleviate snoring and reduce OSA. The benefits of this device are it permits normal mouth opening, allows speech and drinking, provides full lip-seal, easily adjustable, safe and effective, clinically proven custom-fitted. Additionally, the SomnoDent MAS is made from durable fade-proof acrylic that retains its shape and color for at least four-five years and is covered by a two year manufacturer's warranty. FDA Approval received July 2005.

FDA Approval received for the complete line of SomnoGuard oral appliances (the 1-part boil & bite devices SomnoGuard and SomnoGuard 2.0, the 2-part adjustable boil & bite SomnoGuard AP and the two part custom made SomnoGuard AP Pro for fabrication by dental labs) the FDA 510(k) approval under the clearance number K061688 on September 8, 2006

An ample presentation of all the current appliances (CPAP Pro³⁴, Clasp Retained Mandibular Positioner³⁵ (CRMP), Luco Hybrid OSA Appliance, NORAD, Nocturnal Airway Patency Appliance (NAPA), OASYS (Oral Airway System), OPAP (Oral positive air pressure), OSAP, PM Positioner³², Adjustable PM Positioner, Silencer, Snore-aid, Snore free, Silent Nite, Sleep Apnea Goldilocks Appliance (SAGA), Snore-Aid³⁶, SnoreFree, SUAD, TheraSnore, Z Appliance) used would be beyond the framework of the article. The major side effects of oral appliances is the occlusal function. Pancer³⁷ et al evaluated the side effects using a questionnaire and found that less than 45% patients complained of excessive salivation, tooth discomfort, and jaw discomfort.

CONCLUSION

There is no “best appliance”. The best one is that which is comfortable to the patient and achieves the desired efficacy. As dental professionals, we have a significant role to play in the early diagnosis, management and care of patients suffering from sleep Apnoea. A sleep disorder often increases the risk of cardiovascular, metabolic, and neurologic diseases. Oral appliances play a major role in the non-surgical management of OSA and have become the first line of treatment in almost all patients suffering from OSA. Oral appliances are an effective treatment of OSA improving variety of physiologic and behavioural outcomes. The simplicity and cost of the custom mouth protector makes its use applicable to a wide range of patients for the potential preservation of oral structures. Hence, we should familiarize ourselves with this treatment modality.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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