Annals of R.S.C.B., ISSN:1583-6258, Vol. 26, Issue 1, 2022, Pages. 1011 - 1020
Received 08 November 2021; Accepted 15 December 2021.

Role of Oral Appliances as an Effective Treatment Modality for Sleep Apnea

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ABSTRACT

Over the last few years, there has been a rise in public awareness regarding obstructive sleep apnea (OSA). Patients who suffer from this disease are at a risk for other diseases, road traffic accidents and higher mortality. Patients with sleep disordered breathing experience hypersomnia, morning headaches, nausea, and restless sleep at night with frequent arousals. However, often their signs and symptoms are overlooked and neglected due to incognizance on part of the dentists. As a result, despite its high prevalence, it is frequently misdiagnosed. A normally appearing snoring can lead to progressive form of obstructive sleep apnea which can result in medical conditions like polycythemia and right sided heart failure. A greater understanding of these connections would improve skills in offering a more holistic approach to care for patients. Although continuous positive airway pressure (CPAP) is the first line of treatment for sleep apnea, mandibular advancement devices play a significant role, requiring dentists to have a strong grasp of occlusion, TMD, and removable appliance treatment. This article will provide an overview of oral appliances that can be used for the treatment of this serious disorder.

Keywords:-Obstructive sleep apnea, Mandibular advancement device, Herbst mandibular advancement splint, Moses appliance, Klearway appliance.

Introduction

Obstructive sleep apnea/hypopnea syndrome is characterized by recurrent episodes of partial or complete upper airway collapse during sleep and a decrease of 30– 50% in airflow for 10 seconds, 15 or more episodes in an hour of sleep[1]. Based on available population-based studies, the pervasiveness of OSA is approximately 3 to 7% for adult men and 2 to 5% for adult women[2]. OSA has been linked to an increased risk of hypertension, Type 2 Diabetes Mellitus, atrial fibrillation, heart failure, coronary artery disease, stroke and death[3]. The pathophysiology of OSA is a complicated interplay between normal sleep-related functional changes and normal and aberrant anatomical variables that lead to the constriction of the upper airway and, as a result, partial or total obstruction[4]. OSA can be diagnosed either at home or lab-based sleep testing, and effective treatments are available which involves history taking, physical examination, diagnostic testing, polysomnography and portable monitoring[3]. The apnea-hypopnea index (AHI) or respiratory disturbance index is used to assess the severity of OSA[5]. AHI <5/hour is considered as to be normal, whereas AHI = 5–14.9/hour indicates mild OSA, 15–29.9/hour indicates

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moderate OSA and ≥30/hour indicates severe OSA[6]. Current guidelines by the American Society of Anesthesiologists (ASA) recommend preoperative polysomnography when indicated[7]. PSG is considered to be the touchstone for diagnosing sleep-related breathing disorders, including obstructive sleep apnea, central sleep apnea, and sleep-related hypoventilation/hypoxia[8]. Behavioral interventions, medical equipment and surgery are all effective therapies for treating OSA [3]. Although continuous positive airway pressure remains the initial line of defence, there is an important role of mandibular advancement devices, which require dentists to have a good understanding of occlusion, temporomandibular disorders and removable appliance therapy[9].Various medical and surgical treatment modalities have been evolved to treat the OSA for last few decades; however; every treatment has its own advantages and limitations. This review will provide an overview of available oral appliances for treatment of this serious disorder.

PATHOPHYSIOLOGY

The pathogenesis of OSA is complicated by a complex interplay between normal sleep-related functional changes and anatomical variables, both normal and aberrant, that lead to constriction of the upper airway and, eventually, partial or total obstruction. According to Bernoulli, a column of air moving through a narrowed conduit has a slower velocity and exerts more pressure on the lateral walls. When the conduit is narrowed, the air velocity increases while the pressure imposed on the lateral walls from within the narrowed lumen drops. The Venturi effect simply describes how airflow accelerates as it travels through a constriction. The pathophysiology of OSA can be studied using these ideas. The pressure generated within the airway during inspiration, for example, is slightly lower than atmospheric pressure due to the action of the respiratory muscles expanding the lung volume. Air will flow slowly and exert pressure on the pharyngeal walls as long as there is no narrowing in the airway, maintaining a balance. However, if the upper airway narrows, the air will flow faster and exert less pressure on the lateral walls, putting the upper airway at risk of collapsing[10].

OPTIONS FOR TREATMENT

1. Behavioural modification: weight loss, alcohol abstinence, change in sleep posture
2. Positive airway pressure
3. Oral appliances
4. Upper airway surgical procedures
5. Pharmacologic treatment

ORAL APPLIANCES

To prevent airway collapse, oral appliance repositions the tongue and jaw forward and downwards. According to a review of the literature on clinical trials, Oral appliances for the treatment of sleep apnea and snoring were being tested and the treatment success with MRA was found in 19 % to 75 % of patients with an AHI < 5, and in 30 % to 94% of patients with an AHI<10[9].

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TYPES OF ORAL APPLIANCES

A. MANDIBULAR ADVANCEMENT DEVICE(MAD):

B.

The mandibular advancement device (figure 1) is a new therapy option for snoring and OSA. For those with mild or moderate sleep apnea, MADs have shown to be a lifesaver. These devices move the jaw anteriorly and inferiorly, causing anatomical changes in the upper airway that allow for an increase in the pharyngeal area. This action stabilises and fixes the jaw and hyoid bone, preventing post-decubitus postero-rotation of these tissues and airway obstruction.Changes in the location of the hyoid bone cause the hyoid bone to move forward. It shifts the suprahyoid musculature into a new balanced posture, allowing the upper airway to expand in volume and permeability. The tongue base muscles shift anteriorly and the pharyngeal fat pads move laterally away from the airway. Pharyngeal collapsibility is reduced as a result of this. MAD was suggested as a first-line treatment for mild OSA and a second-line treatment for moderate to severe OSA in a 1995 recommendation published by the American Academy of Sleep Medicine. However, using this device has been linked to jaw pain, tooth soreness, and hypersalivation[11].

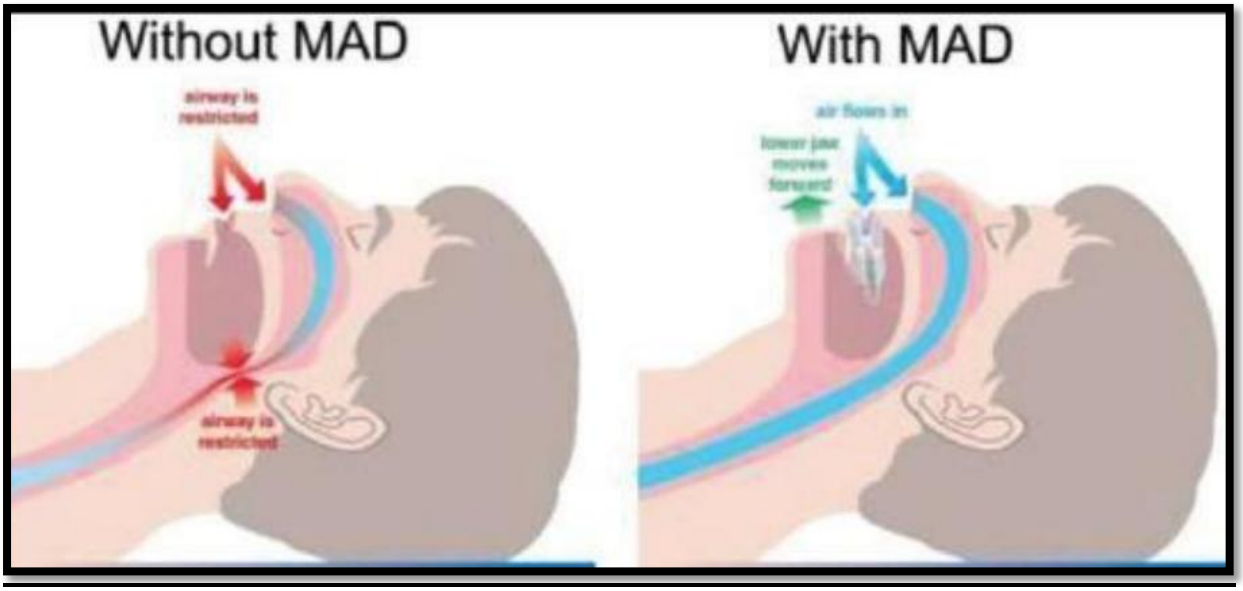

FIGURE 1 Mandibular Advancement Device

C. TONGUE RETAINING DEVICE (TRD)

The TRD (figure 2) features a mouthpiece that covers the whole upper and lower dental arches, has a prominent mandibular protrusion, and draws the tongue forward due to the device's lingual compartment's negative pressure. In a study conducted by Lazard DS1, 71 percent of the subjects responded. With the TRD, the AHI dropped substantially from 38 ± 22.2 to 14 ±13.2, equal to a mean drop of 27 ± 21.3[12]. However, Banhiran W, in a comparative study, concluded that CPAP is superior to TRD for resolving PSG parameters; however, both similarly improve QOL and daytime sleepiness. TRD could be viewed as a short-term alternative treatment for OSA[13].

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FIGURE 2 Tongue retaining device

C. **MANDIBULAR REPOSITIONING APPLIANCE (MRA):**

MRA (figure 3) has been demonstrated to alleviate velopharyngeal obstruction, increase the lateral dimension of the upper airway, and increase the cross-sectional area of the velopharynx in both the lateral and anteroposterior dimensions. Progressive mandibular advancement produces variable adaptive changes in the velopharyngeal and oropharyngeal regions whilst active mandibular advancement causes an increase in upper airway calibre at most levels, and especially at the oropharynx. General design principles involve the use of traditional dental techniques to attach a one- or two-piece appliance to one or both dental arches. Designs range from relatively simple acrylic mouldings to appliances that incorporate metallic rod and tube fittings, interarch elastic, metal or plastic connectors, or even magnets. To maximise tolerance during this initial phase, the conventional approach to MRA treatment typically involves 4 weeks of adaptation to the appliance followed by 2–3 months of incremental titration. While CPAP is unquestionably the most effective treatment for OSA, there is now strong evidence from RCTs that patients find MRA a more acceptable treatment than CPAP and that for an important subset of patients (30–40%) MRA treatment is as effective as continuous airway positive pressure. However, Discomfort from the appliance is the major cause for discontinuation of treatment or poor compliance for about 20–50% of initially treated patients[14].

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FIGURE 3 Mandibular repositioning device

D. Herbst Mandibular Advancement Splint (HMAS) (figure 4):

These are used in cases where nasal CPAP is poorly tolerated and it can be offered to patients with mild to moderate sleep apnea and simple snorers. The Herbst splint is fabricated in two parts linked by rigid metal connectors between upper and lower sections and this allows little mandibular movement once the splint is in place. Patients who have bruxism may attempt excessive lateral excursions and this may cause the splint to fracture at the junction of the metal attachments and the acrylic. With this splint, mandible is extended to 75% of its maximal protrusion with an average of 6.9 mm forward movement. The superior airway, i.e., air space posterior to the soft palate, length of the soft palate and the velopharyngeal aperture is increased. The posterior air space, i.e., space between the tongue base and posterior pharyngeal wall is extended by the forward mandibular and lingual movement up to 56% in cross-sectional area. Studies have shown a significant improvement in the AHI with the use of these prostheses. However, oral appliances are more effective in mild to moderate disease and less in severe OSA. In severe OSA nasal CPAP was more seem to be more effective[15].

FIGURE 4 Herbst mandibular advancement splint

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E. THE MOSES APPLIANCE AND THE MOSES BITE (figure 5):

It may be appropriate for patients who can tolerate the upper and lower jaws being "locked" together. There is a lot of tongue space in many patients, that is extremely important. For TMJ patients however, this can be problematic, as it is the motion of the mandible that circulates the synovial fluid in the joint capsule. The tongue protrudes and the airway is enlarged to an open anterior design combined with mandibular advancement. The advancement screws on the buccal side of the device provide for an open anterior space for the tongue, and the device's base is built with acrylic guides that prod the tongue into a protruding or anterior position. It raises the tongue to the hard palate, increasing nasal airflow and preventing tongue collapse on the throat[16].

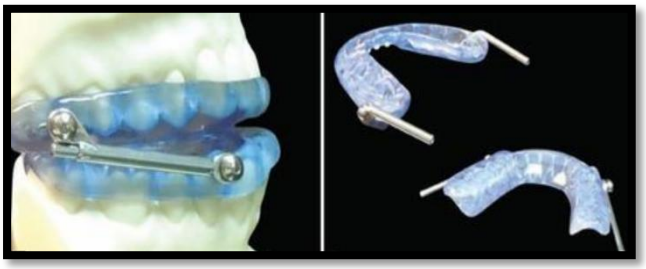

FIGURE 5 The Moses appliance and The Moses bite

F. TWIN BLOCK APPLIANCE:

The primary idea behind a twin block appliance (Figure 6) is to move the tongue forward by expanding the maxilla and moving the jaw forward. As an alternative to the range of one-piece appliances that inhibit normal function, twin blocks are separate upper and lower appliances that provide freedom of movement of the mandible. Titration is as simple as trimming the blocks to reduce activation or adding Triad material if additional activation is required. This allows fine tuning to achieve a balanced occlusion and to optimize comfort. These appliances are aesthetic and can be worn during the day to help drivers with sleep apnea[16].

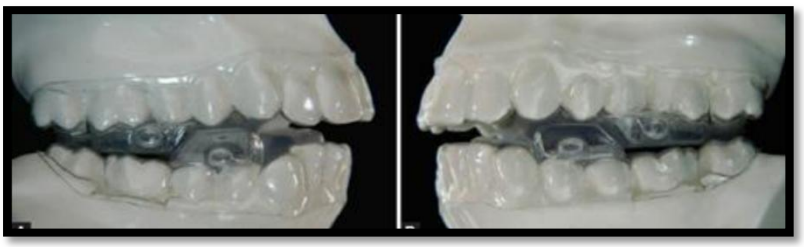

FIGURE 6 Twin Block appliance

G. KLEARWAY APPLIANCE:

This appliance (Figure 7) keeps the teeth together and holds the lower jaw and tongue forward during sleep to open the airway and provides full occlusal coverage of both arches and is designed not to encroach on tongue space. Furthermore, it facilitates the slow and gradual movement of the mandible by permitting the patient to adjust the appliance according to his or her own comfort level with the guidance of the attending dentist. This fully adjustable OA is

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much more comfortable to wear than a single-jaw-position appliance. Klearway becomes pliable for easy insertion and conforms securely to the dentition for an excellent fit while significantly decreasing soft tissue and tooth discomfort. Forty-four forward positions are available in increments of 0.25 mm, which covers a full 11.0-mm range of antero-posterior movement. Such small increments help avoid the rapid forward jaw movements that can cause significant patient discomfort[17].

FIGURE 7 Klearway appliance

H. SOFT PALATE LIFTING APPLIANCE:

This device (figure 8) displaces the soft palate superiorly and posteriorly in order to assist the soft palate to affect closure with the peripheral pharyngeal tissues and helps to improve the airway passage by increasing the upper pharyngeal dimensions. A palatal lift prosthesis treats palatopharyngeal incompetence by physically moving the defective soft palate in the hopes of closing the palatopharyngeal port and preventing nasopharyngeal regurgitation of liquids or solids during the pharyngeal phase of swallowing. A palatal lift prosthesis has an oral component that stabilises and secures the prosthesis, as well as an oropharyngeal extension that displaces the damaged soft palate superiorly and posteriorly[18].

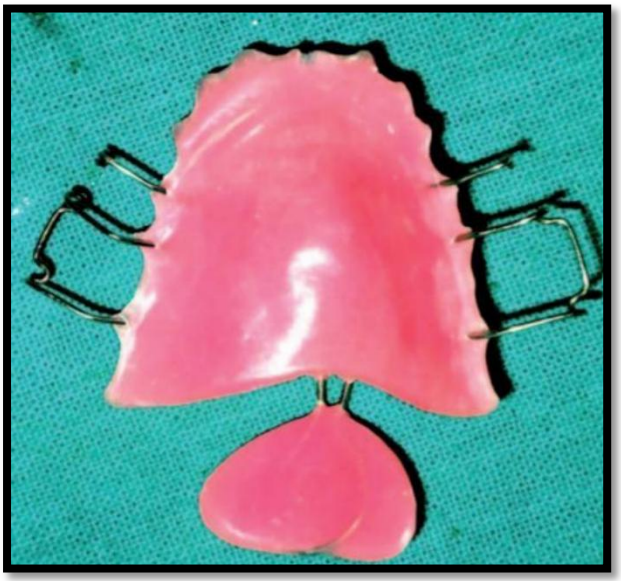

FIGURE 8 Soft palate lifting device

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DISCUSSION:

Surgical procedures, CPAP, and MRA are not equal possibilities for all OSA patients; rather, each therapy modality has a degree of appropriateness dependent on a complex combination of factors, including as OSA severity, medical comorbidities, craniofacial abnormalities, and patient desire.Lifestyle changes such as weight loss and regular exercise are recommended for milder cases of obstructive sleep apnea. If these measures fail, certain devices, such as positive airway pressure, can assist in opening a blocked airway. Oral appliance therapy has emerged as an alternative to CPAP for patients with mild to moderate OSA who refuse or fail to use the CPAP device. Surgery, on the other hand, is considered a last resort and is usually recommended when other therapies are ineffective and in severe cases of OSA[19]. Lawton et al. observed that the Twin Block (a fixed MAD) and the Herbst (an adjustable MAD) were equally effective in improving Apnea-hypopnea index (AHI), snoring, and oxygen saturation but that the Herbst appliance gave better results for daytime sleepiness[20]. MADs were generally successful in improving subjective daytime sleepiness in a systematic review comparing MADs of various designs with inactive control appliances or control MADs with different design features as treatment options for OSAS; this suggests that mandibular advancement is crucial in establishing potency[21]. In a study by Walker Engström *et al.,*The one-year follow-up of patients treated with a mandibular repositioning appliance or uvulopalatophayngoplasty suggests that the former should be preferred in the treating mild to moderate OSAHS. Despite the fact that both programmes' effectiveness rates decreased over a four-year period, MRA therapy was still more effective than uvulopalatophayngoplasty[22]. However, definitive conclusions about the long-term effects of MRA therapy on the craniomandibular and craniofacial complex are not possible. Controlled studies are needed to evaluate MRA therapy's long-term co-morbidity. Moreover, controlled studies should address the specific effects of MRA design, degree of mandibular protrusion, and treatment duration on the occurrence and progression of adverse effects in MRA treatment[23]. More research into identifying the best patients for oral appliance therapy will allow for more generalised treatment guidelines and improved outcomes. By developing more in-depth dental sleep medicine training within prosthodontic residency programmes with access to multidisciplinary teams and ensuring that dental sleep medicine continues to strive for excellence in the management of sleep with oral appliances, prosthodontists can set a new standard.

CONCLUSION

Sleep apnea is a widespread sleep disorder that affects at least 4% of the adult population and has been related to a number of serious daily repercussions, including poor performance, accidents, hypertension, heart disease, stroke, and insulin resistance. There is no doubt about the importance of early and better detection and treatment of sleep apnea, as well as the role that dental professionals can play in facilitating diagnosis, improving patient education, and developing device methods to potentially address a variety of upper airway obstructions. However, further studies are required to predict which OSA patients are at risk of specific chronic diseases. Future research should be directed at identifying factors promoting timely screening of at-risk populations. Therefore, as dental professionals we have a significant role to play in the early diagnosis, management and care of patients suffering from sleep apnea.

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