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Oral Appliances for Obstructive Sleep Apnea

Nor Masitah Mohamed Shukri[1], Dr. Dhanraj [2]
[1]*Graduate,Saveetha Dental College,*
Saveetha Institute of Medical and Technical Sciences,Chennai, India
[2]*Head of Department,Department of Prosthodontics,Saveetha Dental College and Hospital,*
Saveetha Institute of Medical and Technical Sciences,Tamil Nadu, India

Abstract

The aim of this review is to evaluate the use of oral appliance (OA) to treat obstructive sleep apnea (OSA). The word 'oral appliance' is a generic term used for devices that is inserted inside mouth for the purpose of modifying position of mandible, tongue and other structures in the upper airway [1]. During early 1902, an oral appliance had been recognized as a device to treat mandibular deficiency and upper airway obstruction [2]. This review will discuss about the efficacy of oral appliances in patients with OSA.

Keywords : airway, obstructive, sleep apnea, snoring and upper airway

INTRODUCTION

Obstructive sleep apnea is a syndrome characterized by a partial or complete upper airway obstruction during sleep. This condition may lead to snoring, reduction (hypopnea) and cessation (apnoea) of airflow. This syndrome is a commonly can be seen in adult females at least 2% and 4% in adult males [3]. The pathophysiology of OSA involves factors that relate to the anatomical dimensions of the upper airway, upper airway resistance and upper muscle activity during sleep [4].

Patients with OSA normally are being reported that they snores loudly with an apnoea that is associated with respiratory effort and they resume sleep after an awakening. The cycle of this condition may be repeated during their sleep. Also, they may experience excessive daytime sleepiness, impairment of cognitive function, mood swing, decreased libido and social withdrawal [5]. Besides, OSA also can result episodic hypoxemia and arousal and road accidents, which has legal implications. In some countries, people with OSA need to report this to the appropriate licensing authority [6].

Oral appliances are frequently used as a alternate treatment for individuals with OSA that uncomfortable with other therapies or unwilling to do complex procedures. Modifying the position of mandible within restricted mobility attached by pterygoid muscles and temporomandibular joint is one of example to correct types of occlusal disorders [7]. American Academy of Sleep Medicine had published a paper on clinical use of oral appliances in the treatment of snoring and OSA during 1995 that evaluate practice guideline based on Level V evidence. These guidelines expand significantly and become one factor new recommendations of oral appliances were made [8].

TYPES OF ORAL APPLIANCES / TREATMENTS FOR OSA

Mandibular Advancing Devices (MADs)

MADs were invented from plaster casts of teeth by dental technicians and its construction bites were from the dentist. Before 1993, all patients were treated with hard acrylic but then after 1995, they used same devices with soft elastomeric devices. The devices were designed to move the tongue and soft palate and allow mouth breathing and speech by advancing and opening the mandible. The advancement of mandible should be between 4mm and 6mm and its opening at least 5mm between the incisors.

The degree of mandibular advancement was measured on plaster cats in the premolar area and along on occlusal plane from the upper right central incisor to mesial cusp of the upper first molar or premolar if the molar is missing. The mandibular opening was measured as the distance between the upper right and lower incisor edge plus the overbite. These measurements were performed on the initial plaster casts using the most recent construction bite at the time of the sleep apnea recording with the device [9]. Several appliances were evaluated in Table 1 [10].

Tongue Retainers

Oral appliance that is designed to keep tongue in an anterior position during sleep is considered as second class. It is normally used in patients with large tongues and they experiments with the amount of forward positioning of tongue that is required to decrease snoring [11]. These devices guard the tongue via a flange that fits between lips and teeth to hold the device and tongue anteriorly in oral cavity from negative pressure in a soft plastic bulb.

In addition, this device also function to modify mandibular posture by downward rotation. It has been fabricated from dental impressions, but a prefabricated version, suitable for molding to the patient's teeth is available in clinic [12].

Dental Orthosis

This device is fabricated to increase the size of upper airway through advancing the mandible. It is examined by lateral cephalograms at a standard distance of 1.3 meters and is believed that is an effective measure to treat obstructive sleep apnea of moderate severity. An acrylic polymer and the patient's dental impression are used to construct dental orthosis. The device is attached to the upper teeth and to advance mandible by means of a projection, which engages the mandibular incisors when the teeth are approximated.

Dental orthosis was constructed to position the mandible 3 mm posterior to the position of maximal acceptable

advance. The opening between maxillary and mandibular incisors was determined by the required thickness of the material used. Its size is reduced in order to limit discomfort and salivation [13].

VARIABLES AFFECTING ORAL APPLIANCES EFFICACY

Respiratory Disturbance

Based on nine studies [14-22], cases with severe OSA showed a lower success rate as defined by apnea hypoapnea index (AHI), which is between 14 to 61 %. Meanwhile, in moderate respiratory disturbances, success rated between 57 to 81%. However, it was difficult to made comparison between these studies as they were all differ in the definition of success. For example, some studies used different design of devices in which some have optimal position of advancement whereas others were single position. Also, different inclusion criteria and exclusion criteria may affect the success rate in each studies of the same device. It can still be concluded that patients with lower AHI have better success rate compared to in severe OSA. An evaluation of some appliances and their success rate was tabulated in Table 1 [10].

Degree of Protrusion

Normally, mandible can be protruded to a degree of 6 to 10 mm and commonly seen in 50% to 75% of patients could protrude the mandible on request. Several studies reported that increased mandibular protrusion has greatly lessened respiratory events. Many studies were done to evaluate the total amount of vertical opening of oral appliances and their efficiency of production. It was found that patients complained of pain and discomfort during higher vertical opening with no efficacy or side effects. On the other hand, other studies reported slight increase impact on efficacy at lowering the AHI with greater vertical opening of jaws, which varies from 5mm to 12mm of opening [10].

In one study, the great vertical opening of obstructive apnea did not affect on its efficacy and caused some discomfort of jaws instead [23]. The study by Walker-Engström and colleagues compared 2 different degrees of mandibular protrusion, which was 50% or 75% of maximum using the same device in both groups [24]. The MRA set at 75% reduced the AHI to < 10 in 52% of patients whereas the MRA set at 50% of maximum reduced the AHI to < 10 in 31% of patients. They did not find increased side effects with more protrusion [25].

Position During Sleep

A total five studies assessed the affect of different sleep position on breathing disorders by evaluating rate of respiratory events. Two of them reported supine sleep position had better prognosis of the treatment [17,26]. Others concluded that there was a possibility of treatment success if the difference the rate of respiratory events between lateral and supine sleep position were greater [22,27,28].

Body Mass Index

One study has found evaluated that weight gain was adversely associated with efficacy of mandibular repositioning appliances (MRA) [20,21,24]. A higher body mass index caused a lower efficacy of (MRA) but not all in studies [27].

MECHANISMS OF ACTION

The goal of treatment with an oral appliance is to enlarge the upper airway and/or by decreasing upper airway collapsibility.

Effects on Upper Airway Size

Studies found different effects in which most related to methodology. For instance, a passive mandibular advancement is able to increase upper airway size in retropalatal and retroglossal area by stabilizing them [29] and applying an active anterior movement of tongue or mandible of the subjects can also increase a cross sectional airway size. This active method is applicable in subjects with or without OSA [30]. Next, other studies reported that greater protrusion of mandible were capable of lowering AHI in patients wearing appliance, which suggests that MRA has ability to reduce AHI with the relation of protrusion of mandible [11]. Effects of MRAs were also done by using upright lateral cephalometry with films taken during consciousness. Results shown greater posterior airway space, reduced mandibular plane to hyoid distance (MPH), widen upper oropharynx and lowered tongue position in subjects with MRAs. Magnetic resonance imaging, computed tomography and direct imaging of awake supine airway with videoendoscopy were also demonstrated increased in pharyngeal and velopharynx airway size (A).

Effects on Upper Airway Muscle Tone

One study has shown repositioning of mandibular increased the upper airway muscle tone with a MRA, but with an exception in the post-apnea period [31]. The use of tongue retaining devices (TRDs) gives effect to genioglossus muscles activity in subjects with OSA. Decreased the AHI and genioglossus muscle activity were observed with TRD worn during sleep [32]. Upper airway can be increased at different level with different patients. As conclusion, a greater protrusion of mandible will give a high efficacy of oral appliances [11].

Effects The Use Of Dental Orthosis

Long-term effect of the use of dental orthosis can improved sleep quality, less sleepiness and a return of symptoms when the orthosis was omitted for one night. It is because sleep apnea was reduced in majority patients as every patient was improved when orthosis was reinserted. However, not every of them were perfectly treated with the use of dental orthosis. Patients that are likely to prefer CPAP are less likely have a satisfactory response and they usually associated with severe sleep. As for mild patients, dental orthosis may improve upper airway function as well to produce a satisfactory result. Table 2 shows the improvement of using orthosis associated with minimum oxygen saturation [13].

Table 1 : Studies with Different Devices

Author	N	Device	Selection	Percent Success	ESS		AHI		Follow-up Time	Protrusions
					Pre	Post	Pre	Post		
Barthlen	8	Snore Guard	AHI 25 to 137	62% (AHI<15)			72.1±39.9	35.5±39.4	8 months	3-5mm
Ferguson	25	Snore Guard	AHI 15-30	48% (AHI<!0)			19.7±13.8	9.7±7.3	4 months	7mm 7mm vertical
Hans	13	Snore Guard	AHI>10	31% (AHI<10)	12±3.9	8.2±4	53.9±35.6	36.5±43.7	2 weeks	6-8mm
Bloch	24	Herbts	AHI>5	66% (AHI<10)	13.1±0.9	8.8±0.7	22.6±3.1	8.7±1.5	1 week	10mm protrusion
Eveloff	24	Herbts	AHI>10	42% (AHI<!0)			34.7±5.3	12.9±2.1	13 months	Individualized
Clark	23	Herbts	AHI>15	19% (AHI<!0)			33.9±14	19.9±12.8	2 weeks	65% of max protrusion
Millman	24	Herbts	AHI>10	42% (AHI<!0)			37.2±7.1	15.3±4.4	13 months	66-75% of max protrusion
Pancer	75	TAP	Snoring or Mild to Severe OSA	53% (AHI<10)	11±5	7±3	44±28	12±15	12 weeks	Self-adjusted
Skinner	14	TAP	AHI 10-40	50% (AHI<10)	12±5	6±4	34±22	10±5	6-8 weeks	Self-adjusted

Table 2 : Treatment Success Rate

Treatment/Orthosis*	Before/Out	With/Out	With/In	p†
All patients, N = 20				
Weight, kg	86.5	. . .	86.8	. . .
	(81.7, 91.3)		(82.0, 91.7)	NS
Apnea-hypopnea index	47.4	55.8	19.7	
	(34.2, 60.6)	(33.8, 77.9)	(10.9, 28.5)	<0.001
Stage T,‡ % NREM	47.0	44.4	10.6	
	(32.1, 61.9)	(20.0, 68.8)	(−0.8, 22.0)	<0.001
O_2 Saturation, minimum, %	74.5	. . .	80.4	
	(69.8, 79.2)	. . .	(78.2, 82.7)	<0.02
Patients with polysomnogram before and with treatment, N = 15				
Weight, kg	88.3	. . .	89.3	
	(82.6, 94.0)	. . .	(83.7, 94.9)	NS
Apnea-hypopnea index	45.5	50.3	19.3	
	(30.4, 60.6)	(29.1, 71.5)	(8.1, 30.5)	<0.001
Stage T,‡ % NREM	44.3	39.5	10.6	
	(28.5, 60.0)	(14.7, 64.3)	(−1.7, 22.9)	<0.001
O_2 Saturation, minimum, %	73.5	. . .	80.6	
	(67.7, 79.3)	. . .	(78.0, 83.2)	<0.02
Patients with follow-up polysomnogram without and with treatment, N = 11				
Weight, kg	89.5	. . .	91.2	
	(83.1, 95.9)	. . .	(85.1, 97.3)	NS
Apnea-hypopnea index	59.4	55.8	29.4	
	(40.3, 78.5)	(33.8, 77.8)	(16.3, 42.5)	<0.01
Stage T,‡ % NREM	48.9	44.4	13.5	
	(28.7, 69.1)	(20.0, 68.8)	(−0.7, 27.6)	<0.01
O_2 Saturation, minimum, %	73.4	. . .	79.4	
	(66.4, 80.4)	. . .	(76.5, 82.3)	0.05

*Mean (95 percent confidence interval).
†Paired Student's *t*-test: before treatment, orthosis out vs with treatment, orthosis in.
‡Stage T, NREM sleep that is fragmented by stereotypic arousals related to respiratory disturbance.

SUMMARY

The use of oral appliances for OSA has improved gradually in latter years in terms of quality and quantity. Most patients report improvements in sleep quality in which approximately they achieve an AHI of <20. Oral appliances present a useful and alternative device to people suffering OSA who cannot tolerate nasal CPAP. The side effect such as salivation, muscle and tooth discomfort are common and can be improved over time. Oral appliances also present unique chances for dentists and doctors to provide care for patients suffering OSA [11]. The role of dentistry in sleep disorders is becoming more important as it has the opportunity to manage patients with OSA at variety levels of starting with consultation with physician, early recognition of sleeping disorder and its management [33].

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