Oral appliances for obstructive sleep apnea
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INTRODUCTION
Obstructive sleep apnea (OSA) is a syndrome characterized by a partial or complete upper airway obstruction during sleep. This condition may lead to snoring, reduction (hypopnea), and cessation (apnea) of airflow.[1,2] This syndrome is commonly 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 snore loudly with an apnea that is associated with respiratory effort and they resume sleep after awakening. The cycle of this condition may be repeated during their sleep. Furthermore, they may experience excessive daytime sleepiness, impairment of cognitive function, mood swing, decreased libido, and social withdrawal.[5] Besides, OSA also can result in 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 (OA) are frequently used as an 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 the temporomandibular joint is one of the examples to correct types of occlusal disorders.[7] American Academy of Sleep Medicine had published a paper on the clinical use of OAs 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 OAs were made.[8]

TYPES OF OAS/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 the 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 4 mm and 6 mm and its opening at least 5 mm between the incisors.

The degree of mandibular advancement was measured on plaster casts in the premolar area and along on occlusal plane from the upper right central incisor to
the 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. Several appliances were evaluated in Table 1.

Tongue Retainers

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

In addition, this device also functions 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 the clinic. OA that is designed to keep tongue in an anterior position during sleep is considered as a second class. It is normally used in patients with large tongues and they experiment with the amount of forward positioning of tongue that is required to decrease snoring. These devices guard the tongue through a flange that fits between lips and teeth to hold the device and tongue anteriorly in the oral cavity from negative pressure in a soft plastic bulb.

Dental Orthosis

This device is fabricated to increase the size of the upper airway through advancing the mandible. It is examined by lateral cephalograms at a standard distance of 1.3 m and is believed that is an effective measure to treat OSA 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 maximally acceptable advance. The opening between maxillary and mandibular incisors was determined by the required thickness of the material used. Its size is reduced to limit discomfort and salivation.

VARIABLES AFFECTING OAS EFFICACY

Respiratory Disturbance

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

Degree of Protrusion

Normally, mandible can be protruded to a degree of 6–10 mm and commonly seen in 50%–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 OAs 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 a slight increase impact on efficacy at lowering the AHI with the greater vertical opening of jaws, which varies from 5 mm to 12 mm of opening.

In one study, the great vertical opening of obstructive apnea did not affect its efficacy and caused some discomfort of jaws instead. The study by Gavish et al. compared two different degrees of the mandibular protrusion, which was 50% or 75% of the maximum using the same device in both groups. The mandibular repositioning appliances (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.

Position during Sleep

A total of five studies assessed the effect of different sleep position on breathing disorders by evaluating the rate of respiratory events. Two of them reported supine sleep position had a better prognosis of the treatment. Others concluded that there was a possibility of treatment success if the difference in the rate of respiratory events between lateral and supine sleep position was greater.

Body Mass Index

One study has found evaluated that weight gain was adversely associated with efficacy of MRA. A higher body mass index caused a lower efficacy of MRA but not all in studies.

MECHANISMS OF ACTION

The goal of treatment with an OA 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 the retropalatal and retroglossal area by stabilizing them\(^{[28]}\) 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.\(^{[29]}\)

Next, other studies reported that greater protrusion of mandible was capable of lowering AHI in patients wearing appliance, which suggests that MRA has the ability to reduce AHI with the relation of protrusion of mandible.\(^{[10]}\) Effects of MRAs were also done using upright lateral cephalometry with films taken during consciousness. Results showed greater posterior airway space, reduced mandibular plane to hyoid distance, widen upper oropharynx, and lowered tongue position in subjects with MRAs. Magnetic resonance imaging, computed tomography, and direct imaging of awake supine airway with video endoscopy 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 an MRA, but with an exception in the post-apnea period.\(^{[30]}\) The use of tongue retaining devices (TRDs) gives effect to genioglossus muscles activity in subjects with OSA. Decreased the AHI and genioglossus muscle activity was observed with TRD worn during sleep.\(^{[31]}\) Upper airway can be increased at a different level with different patients. As a conclusion, a greater protrusion of mandible will give a high efficacy of OAs.\(^{[10]}\)

Effects the use of Dental Orthosis

The long-term effect of the use of dental orthosis can improve 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 of patients as every patient was improved when orthosis was reinserted. However, not every one of them was perfectly treated with the use of the dental orthosis. Patients that are likely to prefer continuous positive airway pressure (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.\(^{[12]}\)

**SUMMARY**

The use of OAs for OSA has improved gradually in later years in terms of quality and quantity. Most
patients report improvements in sleep quality in which approximately they achieve an AHI of <20. OAs 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 is common and can be improved over time. OAs also present unique chances for dentists and doctors to provide care for patients suffering OSA.[10] 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 a consultation with a physician, early recognition of sleep apnea and its management.[32]

### REFERENCES

7. Wright J, Johns R, Watt I, Melville A, Sheldon T. 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 a consultation with a physician, early recognition of sleep apnea and its management.[32]

### Table 2: Treatment success rate

<table>
<thead>
<tr>
<th>Treatment/Orthesis*</th>
<th>Before/out</th>
<th>With/Out</th>
<th>VMM*</th>
<th>P†</th>
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<tbody>
<tr>
<td>All patients, n=2</td>
<td></td>
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<tr>
<td>Wight, kg</td>
<td>86.5 (81.7, 91.3)</td>
<td>---</td>
<td>86.8 (82.0, 91.7)</td>
<td>NS</td>
</tr>
<tr>
<td>Apnea-hypopnea index</td>
<td>47.4 (34.2, 60.6)</td>
<td>55.8 (33.8, 77.9)</td>
<td>19.7 (10.9, 28.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stage T, % NRKM</td>
<td>47.0 (32.1, 61.9)</td>
<td>44.4 (20.0, 68.8)</td>
<td>10.6 (−0.8, 22.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>O₂ saturation, minimum, %</td>
<td>74.5 (69.8, 79.2)</td>
<td>---</td>
<td>80.4 (78.2, 82.7)</td>
<td>&lt;0.02</td>
</tr>
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</table>

Patients with polysomnogram before and with treatment, n=15

| Wight, kg           | 88.3 (82.6,94.0) | ---       | 89.3 (83.7, 94.9) | NS  |
| Apnea-hypopnea index| 45.5 (30.4, 60.6) | 50.3 (29.1,71.5) | 19.3 (8.1, 30.5) | <0.001 |
| Stage T, % NRKM     | 44.3 (28.5, 60.6) | 395 (14.7, 64.3) | 106 (−1.7, 22.9) | <0.001 |
| O₂ saturation, minimum, % | 73.5 (67.7, 79.3) | ---       | 80.6 (78.0,83.2) | <0.02 |

Patients with polysomnogram before and with treatment, n=15

| Wight, kg           | 89.5 (83.1, 95.9) | ---       | 91.2 (85.1, 97.3) | NS  |
| Apnea-hypopnea index| 59.4 (40.3, 78.5) | 55.8 (33.8, 77.8) | 29.4 (16.3, 42.5) | <0.01 |
| Stage T, % NRKM     | 489 (28.7, 69.1) | 44.4 (20.0, 68.8) | 13.5 (−0.7, 27.6) | <0.01 |
| O₂ saturation, minimum, % | 73.4 (66.4, 80.4) | ---       | 79.4 (76.5, 82.3) | 0.05 |

*Mean (90% confidence interval), † paired student’s t-test: Before treatment, orthosis out versus with treatment, orthosis in, ‡ stage T, NREM sleep that is fragmented by stereotypic arousals related to respirators disturbance.


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