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Obstructive Sleep Apnea and Oral Appliances- Review

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ABSTRACT
Obstructive sleep apnea is a chronic, progressive and disabling sleep related breathing disorder. It requires long term, multidisciplinary management .Various treatment modalities such as behavioural, medical, surgical options are available. Contribution from various health care specialties could lead to effective treatment benefits when considering treatment for OSA. The most common clinical procedure involves continuous positive airway pressure (CPAP). Orthodontics is not just limited with mere alignment of the teeth and smile esthetics but it has an expanded health care role that has established a new standard of health care for OSA patients. Oral appliances are simple, noninvasive, cost effective and reliable treatment method compare to all other airway pressure therapy and surgical approach in mild and moderate OSA patient.
Key word: *Apnea, CPAP, Obstructive Sleep Apnea, Oral appliance, Polysomnagraphy.*

INTRODUCTION

Obstructive Sleep Apnea is a prevalent but under recognized chronic sleep related breathing disorder with associated substantial morbidity and mortality. It is characterized by recurrent episodes of partial or complete upper airway obstruction during sleep.[1] This manifests as a reduction (hypopnoea) in or complete cessation (apnoea) of airflow despite ongoing inspiratory efforts resulting in oxygen desaturations and arousals. There is accumulating evidence that OSA is being considered as an independent risk factor for hypertension, glucose intolerance / diabetes mellitus, cardiovascular diseases and stroke, leading to increased cardio metabolic morbidity and mortality.[2-5]

Obstructive sleep apnoea syndrome, defined as an apnoea/hypopnoea index (AHI) of 5 or more—that is, at least five apnoeic/ hypopnoeic events per hour of sleep—plus reported sleepiness, is a common form of SDB. According to the American Academy of Sleep Medicine recommendations, OSA is defined with AHI >5, and it is classified as mild OSA with AHI of 5 to 15; moderate OSA with AHI of 16 to 30; and severe OSA with AHI > 30.[1] Overweight middle-aged adult men have the highest prevalence of the disease [7,8] yet women and an increasing number of children are also affected by OSA [9] This condition affects 2% to 4% of adults aged from 30 to 60 years;10 prevalence increases with age. [11]

Table 1. Definitions of terms used in obstructive sleep apnoea [6]

Term	Definition
Apnoea	Cessation of airflow of at least 10 seconds
Hypopnoea	≥50% decrease in airflow amplitude of at least 10 seconds; or <50% decrease In airflow amplitude associated with either an arousal or oxygen desaturation of ≥3%
Respiratory effort-related arousal	An event characterised by increasing respiratory effort for 1 ≥0 seconds,leading to an arousal from sleep but which does not fulfill the criteria for a hypopnoea or apnoea
Apnoea/hypopnoea index	No. of apnoea + hypopnoea episodes per hour of sleep
Respiratory disturbance index	No. of apnoea + hypopnoea episodes + arousals per hour of sleep

POLYSOMNOGRAPHY [12]

The gold standard diagnostic test for OSA is the overnight in-laboratory polysomnography. It involves multi-channel continuous polygraphic recording from surface leads for electroencephalography, electrooculography, electromyography, electrocardiography, nasal pressure transducer (supplemented by thermistor) for nasal airflow, thoracic and abdominal impedance belts for respiratory effort, pulse oximetry, tracheal microphone for snoring, and sensors for leg and sleep position. These recordings will identify different types of apnoeas and hyponoeas during sleep. **Polysomnography (sleep study)** results can reveal the cessation of air flow for 10 seconds even with maintenance of respiratory effort, five or more episodes of apnea per hour and a decreased oxygen saturation of at least 4% during episodes. These findings are indicative of OSA. The ideal OSA treatment, should aim of normalizing breathing during sleep, consequently eliminating excessive daytime sleepiness and neuropsychiatric and cardio-vascular changes with no side effects or risks.[18]

TREATMENT MODALITIES

The American Association of Sleep Medicine (AASM) describes continuous positive air pressure (CPAP) as the gold standard. The AASM also describes eight surgical treatment options and five conservative treatment options for the patient with OSA. The general surgical procedures most commonly include bariatric surgery to assist with significant weight loss and pharyngeal surgery to remove adenotonsillar hypertrophy and/or to reduce the size of the uvula . The dental surgical procedures include genioplasty, mandibular advancement, and maxillomandibular advancement (MMA). Oral appliance therapy is among the conservative treatment options listed. [19]

Table-2 Various Diagnostic tests for OSA

Polysomnagraphy - Gold standard	
Nocturnal Pulse oximetry [13]	CT scan [17]
Multiple sleep Latency Test [14]	MRI
Lateral cephalometric radiographs [15,16]	Visualisation of upper airway

Table 3 - Various Treatment modalities [20]

Treatment Type	Measures used
Conservative	- Lose weight, sleep in lateral position, avoid alcohol
Medical	- Use Nasal continuous positive airway pressure, auto–continuous positive airway pressure, bilevel positive airway pressure - Use oral appliances - Give medication - Treat associated diseases, eg hypothyroidism, acromegaly, Allergic rhinitis
Surgical	- Tracheostomy - Nasal procedure, eg turbinectomy, polypectomy, septoplasty - Uvulopalatopharyngoplasty - Laser-assisted uvulopalatoplasty - Maxillo-mandibular advancement
Experimental	- Pharyngeal pacing - Radio-frequency ablation - Rapid maxillary expansion

ORAL APPLIANCES

Oral appliances have been recommended as a treatment option for being simple to use and non-invasive .[21] These devices are intended to increase the volume of the airways through a mechanical maneuver [22,23.] Several authors stated in their studies that oral appliances are a good alternative for the treatment of snoring and OSAS due to their low cost, relative comfort, and ease of use, which can therefore lead to greater patient compliance.[24,25,26]

These devices offer advantages over CPAP in that they do not require a source of electricity and are less cumbersome, especially with travel. Oral appliances are well-tolerated in most patients and therapeutic adherence may be better than CPAP.[27-30]

Several studies demonstrate that oral appliances can be a useful alternative to positive air way pressure with mild to moderate sleep apnea.[31 ,32] There is also robust evidence of the efficacy of oral appliances for improving polysomnographic indices and modifying the health risk associated with OSA. [33]

Oral device may be helpful in the management of OSA by; improving upper air way potency, increasing the cross sectional area or decreasing the upper air way collapsibility by increasing the muscle tone. [34] The US FDA approved 16 devices for use in sleep apnea oral appliances as an alternative to CPAP therapy. They are designed to keep upper air way open.[35] The theoretical basis for the potential treatment of Oral appliance therapy is that in the supine position, all gravity dependent tissue tends to fall posteriorly, including the tongue and lower jaw. If the oral appliance can prevent one or both, the airway will remain patent reducing the number of apneic and hypopneic events. Although Mandibular Advancement Device (MAD) has positive effect in treatment of OSAS, it has multiple complications. These may include craniofacial change in maxillomandibular relationship and bony dimensions, overbite alteration, tooth pain and TMJ problems. [36]

Oral appliances are devices intended to protrude and stabilize the mandible to maintain a patent airway during sleep. [37]

A custom OA is “fabricated using digital or physical impressions and models of an individual patient’s oral structures. As such, it is not a

primarily prefabricated item that is trimmed, bent, relined or otherwise modified. It is made of biocompatible materials and engages both the maxillary and mandibular arches." Non-custom OAs, commonly known as "boil and bite devices," are primarily pre-fabricated and usually partially modified to an individual patient's oral structures. In addition to being custom- or non-custom made, OAs are either titratable or non-titratable. Titratable OAs have a mechanism that allows for varying amounts of mandibular protrusion. The increasing protrusion of the mandible is considered analogous to the titration of continuous positive airway pressure (CPAP). Non-titratable OAs hold the mandible in a single protrusive position and no changes are possible over the course of treatment.

ORAL APPLIANCE THERAPHY RATIONALE

The theoretical basis for the potential treatment effect is that in the supine position, all gravity dependent tissue tends to fall posteriorly, including the tongue and lower jaw. If the oral appliance can prevent one or both, the airway will remain patent reducing the number of apneic and hypopneic events. The gold standard assessment requires PSG, and this has been performed in case reports, case series, and prospective non-randomized studies. Limited sample sizes, high dropout rate, lack of controls, short study duration, and other factors make interpretation and application of these investigations difficult.[38,39]

More recently, higher levels of evidence using PSG in prospective randomized control studies have emerged. Okuno[40] demonstrated that oral appliances improved AHI more than control appliances, although less than CPAP. Contrary to previous investigators[41,42] their study group demonstrated similar compliance rates with oral appliances or CPAP.

In a short-term prospective randomized cross-over study, Phillips[43] compared the results of CPAP and a mandibular advancing device (MAD). With over 100 patients completing both arms of the study, the MAD achieved complete resolution in 40% and partial resolution in another 25% of patients in contrast to CPAP which achieved complete resolution in 75% and partial in 15% of patients.

Nelly et al[44] investigated the efficacy of orthopedic mandibular advancement and/or rapid maxillary expansion in the treatment of pediatric obstructive sleep apnea. A total of 58 studies were identified. Only eight studies were included in the review; of these, six were included in the meta-analysis. Although the included studies were limited, these orthodontic treatments may be effective in managing pediatric snoring and obstructive sleep apnea. Other related health outcomes, such as neurocognitive and cardiovascular functions have not yet been systematically addressed.

Based on a single retrospective study by Holley 2011, however; there was no significant difference in the percentage of mild OSA patients achieving their target AHI/RDI/REI (<5, <10, >50% reduction) after treatment between OAs and CPAP. [For patients with moderate to severe OSA, however, the odds of achieving the target AHI was significantly greater with CPAP than with OAs. [45]

In an RCT conducted by Randerath [46], the odds of achieving the target AHI of <10 in mild to moderate adult patients was significantly greater with CPAP than OA therapy. OA therapy should be reserved for use in severe OSA patients who did not benefit from CPAP therapy or were intolerant to CPAP[47,48]. In a prospective, randomized crossover trial, Robertson et al.[49] found that changes in the Snoring Outcomes Survey were similar with the OA and nasal CPAP. The authors also observed that the OA was superior to CPAP in improving sleep quality among bed partners. More patients in this trial also preferred the OA over CPAP for long-term treatment of snoring.

Ghazal[50] compared two oral appliances, a modified Herbst appliance (IST) and a prosthodontic (TAP) appliance over several years.

The study utilized 103 consecutively enrolled and randomly assigned middle-aged adults. At 6 months, both appliances improved the AHI, with the TAP having a higher percentage of success. By study end (42 months), both appliance groups showed similar results. Caution must be taken with these results as there was significant patient drop out and loss to follow-up leaving less than half the original study population. Of note, this group was among the first to examine not only the AHI, but also the effects of oral appliances on blood pressure, an important consideration given the recent concern that controlling blood pressure (BP) may be more important than AHI in reducing the adverse health effects of OSA [51,52]

With the increasing number or prospective randomized studies, systematic reviews and meta-analyses have now been performed exam-ining different aspects of treatment. Using 14 of a possible 1475 studies that met their initial search criteria, Ahrens and Hagg evaluated oral appliances (one or two piece) vs. control appliances and each other [53]. They concluded that MAD appliances performed better than controls with two-thirds of treated patient's AHI improving. There was no difference between one-piece MAD designs and also no difference for 50% or 75% maximum protrusion. Comparing one- or two-piece design, there was no clearly superior appliance. Using 7 separate studies with a pooled 399 patients, Iftikhar[54] evaluated oral appliances and their effect on BP demonstrating a modest decrease in systolic, diastolic, and mean arterial pressure, although there was no correlation between the reduced blood pressure and the decreased AHI.

CONCLUSION

Sleep medicine is obviously a challenging field, evolving with new technology. There have been major new discoveries and growing evidence in clinical research studies, however, a number of key questions remain unanswered. The mechanisms by which overall health improvements in sleep apnea individuals by means of oral appliance, It should be a focus for future basic and clinical research.

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