



An Algorithm for Clinical Management of Obstructive Sleep Apnea

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ABSTRACT

Purpose: Different approaches for treating obstructive sleep apnea (OSA) have been reported over the years. This review summarizes an overview of the current literature available on the treatment of OSA and proposes an algorithm or clinical workflow for the management of the same.

Methods: Peer-reviewed publications were searched on PubMed and MEDLINE. Articles published in the English language were considered for the review. The keywords used were Obstructive Sleep Apnea, Continuous Positive Airway Pressure, Oral Appliances, Mandibular repositioning appliance, and Management of Obstructive Sleep Apnea.

Results: Behaviour management, continuous positive airway pressure (CPAP), oral devices, and other interventions have been reported to control Obstructive Sleep Apnea. Clinicians should make a treatment plan depending on the clinical diagnosis and the severity of the symptoms of the patient.

Conclusion: Apnoea/Hypopnea index (AHI) should be used by the clinicians for assessing the severity of the disorder prior to treatment. As per the current literature, it was observed that patients have a higher compliance rate with oral appliance therapy as compared to Continuous Positive Airway Pressure.

Keywords: Algorithm, Continuous Positive Airway Pressure, Mandibular Advancement, Oral Appliances, Obstructive Sleep Apnea.

Introduction

Obstructive sleep apnea syndrome (OSAS) is a medical condition characterized by repetitive partial or complete obstruction of the upper airway during sleep.¹ OSAS is associated with hypertension, increased risk for congestive heart failure, coronary artery disease, and myocardial infarction.² It is the most common form

of sleep-disordered breathing (SDB) worldwide as shown in different epidemiological studies.³⁻⁵ The prevalence of OSA ranges from 16% to 37% in young and elderly age groups with no major differences between the sexes (37% in men, 29% in women).⁶ There is an increase in evidence that OSA is an independent risk factor for an adverse cardio-metabolic profile.⁷ OSA has a significant impact on quality of life, as it leads to excessive daytime sleepiness, cognitive impairment, diminished work efficiency, and anxiety.⁸ The etiology of OSA is multifactorial, consisting of a complex interrelation between anatomic, neuromuscular factors and an underlying genetic predisposition towards the disease. Various risk factors are associated such as snoring, male gender, middle age, menopause in women, obesity, and a variety of craniofacial and oropharyngeal features such as a large neck circumference, retro or micrognazia, nasal obstruction, enlarged tonsils/adenoids, macroglossia, and low-lying soft palate.⁹ Despite the recent advances in diagnostic technology in the field of sleep medicine and increased awareness of OSA in the public, a majority of those affected are still undiagnosed.¹⁰ The purpose of this article is to provide an algorithm to the dentist for the management of clinical cases of sleep apnea based on the existing literature.

Methods: A thorough literature review search was performed for the etiology, classification, and management of OSA in peer-reviewed journals using PubMed and MEDLINE. The articles published in English and focussing on the management of sleep apnea were considered for the manuscript. The keywords used were OSA, CPAP, OA and mandibular repositioning appliance, management of OSA. Available abstracts were reviewed and full-text articles based on the abstracts were then included.

Classification: Sleep apnea has been classified into Central sleep apnea, obstructive sleep apnea, and mixed sleep apnea.^{11,12} (Figure.1) Based on the apnea-hypopnea index (AHI), OSA can be classified as mild, moderate, or severe. AHI is determined by the number of apnea and hypopnea events during sleep. Apnea is defined as the complete termination of breathing for more than 10 seconds, and hypopnea is the incomplete termination of breathing. Mild OSA has 5 to 15 events per hour, moderate OSA has 15 to 30 events per hour, and severe OSA has more than 30 events per hour.¹³ (Figure.2)

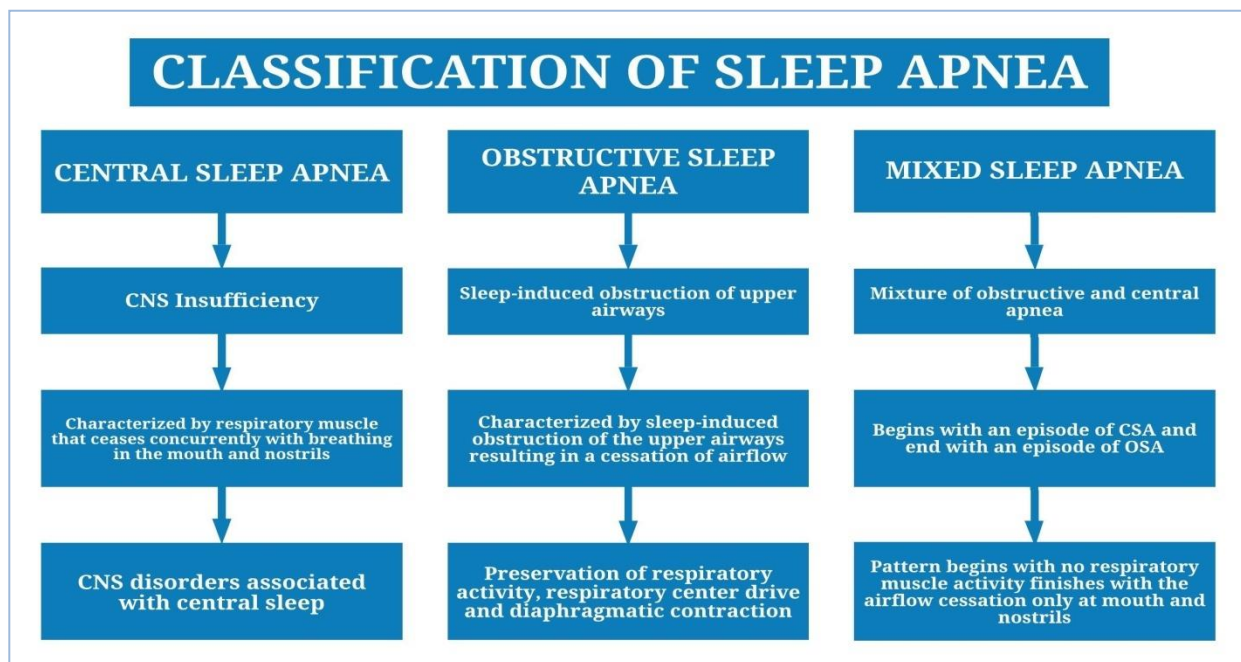


Figure.1: Classification of Sleep Apnea

SEVERITY OF OBSTRUCTIVE SLEEP APNEA	APNEA HYPOPNEA INDEX
Normal Or Primary Snoring	AHI < 5
Mild	5 < AHI < 20
Moderate	20 < AHI < 40
Severe	AHI > 40

Figure.2: Apnea-Hypopnea Index (AHI)

Diagnosis of Obstructive Sleep Apnea: Upper airway imaging modalities primarily include nasopharyngoscopy, cephalometrics, computed tomography (CT), and magnetic resonance imaging (MRI). These imaging modalities have been used to study the effect of respiration, weight loss, dental appliances, and surgery of the upper airway. MRI and CT allow quantification of the airway and surrounding soft tissue structures in three dimensions.¹⁴ In recent years, sleeping fiber optic endoscopy has been applied as an effective method to locate the obstruction site. However, radiological examinations are generally preferred, as high-speed CT locates the obstructive site with higher accuracy as compared to fiber optic endoscopy.¹⁵ Recently, novel imaging techniques using computer fluid dynamics (CFD) have been employed for evaluating the upper airway in OSAS.¹⁶

The diagnosis of OSA is made through different levels of nocturnal monitoring of respiratory, sleep, and cardiac parameters (polysomnography or nocturnal cardio-respiratory polygraphy). It is used to detect obstructive events and changes in blood oxygen saturation (SaO₂). The most commonly used index to define the severity of OSA is the AHI index. It is calculated as the number of obstructive events per hour of sleep and obtained by nocturnal cardiorespiratory monitoring.⁹

Management of Obstructive Sleep Apnea

Management of OSA requires a multidisciplinary approach. The initial treatment of choice for OSA is positive airway pressure (PAP), which can be delivered as Continuous Positive Airway Pressure (CPAP), bilevel PAP, or auto-titrating PAP. Studies have shown improvement in not only daytime sleepiness but also morbidity and mortality with the use of CPAP in the elderly.¹⁷⁻²⁰ Behavioral treatment options may include weight loss, positional therapy, and avoiding alcohol and sedatives before bedtime. Oral appliances can be used as an adjunct or alternative to CPAP therapy options. A mandibular advancement device has been shown to improve OSA symptoms.^{20,21} Various surgical treatment options are available for the management of OSA and sleep-disordered breathing. Due to higher morbidity, surgical treatment is usually considered for patients for whom PAP therapy and oral appliances do not provide adequate relief. Therapy is usually directed at the site of obstruction and is often staged.²² Nasal surgeries include septoplasty, inferior turbinate reduction, adenoidectomy, and nasal valve reconstruction. Procedures for palatal obstruction include tonsillectomy and uvulopalatopharyngoplasty and its modifications. Hypopharyngeal surgeries include lingual tonsillectomy, partial midline glossectomy, mandibular osteotomy, genioglossal advancement, hyoid myotomy, and suspension, as well as maxillomandibular osteotomy and advancement. Newer technologies such as



hypoglossal nerve stimulation implants are becoming more appealing as alternatives to the CPAP treatment option because of lower associated surgical morbidity, good clinical outcomes, and the multilevel effect on airway obstruction.^{23,24}

However, surgical treatments of OSA and sleep-disordered breathing in the elderly are not well studied, in part because of the higher prevalence of comorbid conditions and increased risks associated with general anesthesia in this patient population. In healthy, older individuals with significant sleep-disordered breathing or OSA with CPAP intolerance, individualized surgical treatment options should be considered.²⁵

Continuous Positive Airway Pressure (CPAP)

Nasal CPAP therapy was introduced by Sullivan et al in 1981 for the treatment of OSA.²⁶ Nasal CPAP is produced by a high-flow blower that delivers a continuous stream of room air into a sealed nasal mask that the patient wears while sleeping. The positive pressure created in the circuit pneumatically splints the pharyngeal airway open by preventing the soft palate and tongue from occluding it.²⁷ This therapy abolishes hypopneas, apneas, oxygen desaturations, and apnea-related sleep fragmentation in most patients. The result is the rapid restoration of normal sleep and reduction of daytime sleepiness.²⁸ Patients should be observed in a sleep laboratory to determine the optimal CPAP level. Depending on several factors, this will vary from patient to patient and from time to time.²⁹ The objective of nasal CPAP is to provide sufficient pressure in the collapsible segment of the upper airway to counteract the inspiratory suction pressure. At any instant of the inspiratory cycle, there is a pressure gradient down the entire airway from the nose to the alveoli. The further down the airway, the more negative is the intra airway pressure. In the extrathoracic airway, a transmural pressure gradient during inspiration tends to constrict the airway. In the oropharyngeal muscular tube, this suction pressure is sufficient to close the airway during sleep in patients with OSA. In some patients, the upper airway closes during sleep without a transmural pressure gradient. To maintain upper airway patency, these patients depend entirely on the presence of a sufficient tone in the upper airway musculature. Nasal CPAP effectively places the entire airway in a higher range of static “atmospheric” pressure so that the whole respiratory cycle takes place above atmospheric pressure. At no stage does the oropharyngeal transmural gradient become negative. This provides a pressure splint to the segment vulnerable to closure.^{29,30}

The major concern with nasal CPAP therapy is long-term compliance because continued use of the device requires considerable patient commitment. Patients who suffer from this disorder are likely to be consistent with its use. Sullivan et al, Hoffstein et al, Thornton et al, Rauscher et al noted that when covertly monitored actual CPAP use, compliance was found to be less than what was self-reported by the patients.²⁷⁻³¹ This is why attempts are being made to improve the device to increase its use. Examples of this would include a ramp feature, which starts at a lower pressure and increases gradually after the patient falls asleep, and a bi-level CPAP (BiPAP), which has different expiratory and inspiratory pressures.²⁹

The immediate response to nasal CPAP is dramatic. Typically, within moments of its application, the patient begins to have long periods of uninterrupted sleep, marked rebound in stage 3 to 4 nonrapid eye movement (NREM) sleep occurs, and both the frequency and duration of this stage of sleep increase dramatically. In addition, there are extraordinarily long periods of REM sleep characterized by high-density phasic activity. After CPAP therapy, arousal responses to a variety of stimuli are markedly depressed during the first few nights of treatment.^{32,33}

The sleep rebound continues over a number of nights. By the seventh to tenth night the sleep pattern, distribution, and arousability return to more normal levels. The daytime function of patients is typically

transformed. The loss of daytime somnolence is a characteristic improvement, but other dramatic changes also are seen. Quantitative tests of neuropsychiatric function often show a reversal from a pattern of cognitive deficits, described as unequivocally “brain-damaged” to normal.^{29,30}

Bilevel PAP ventilation provides two different levels of pressure (higher during inhalation and lower during expiration) it is found that it can potentially treat OSA at a lower mean pressure than CPAP, at the same time improving lung ventilation via pressure support. Bilevel PAP is therefore a valid alternative in patients intolerant to CPAP and in patients with associated hypoventilation or chronic obstructive pulmonary disease.³¹ Mandibular advancement devices are effective in mild to moderate OSA and provide a viable alternative for patients intolerant to CPAP therapy.³²

Prosthetic Management of Sleep Apnea

Oral Appliances for Sleep Apnea: The list of appliances is mentioned in **Table 1**. Each oral appliance has a primary effect on either the tongue or the tongue and mandible together. Several appliances move the mandible anteriorly; for example, Herbst, Klearway, Mandibular repositioner, PM Positioner, Snore Guard, and TheraSnore. The tongue is affected by all the appliances either by the direct forward movement of the muscle itself or by changes secondary to an altered mandibular rest position.³³⁻³⁶ The Tongue Retaining Device (TRD) is the most commonly used oral appliance that has a direct effect on tongue posture.³⁷

Appliance	Action	Effects
Herbst	Mandible advancement.	Oxygen desaturation levels improved markedly and the respiratory disturbance index (RDI) decreased from a mean of 48.4 to 12.4 - 4 months after the insertion of a Herbst appliance.
Klearway	Holds teeth together and lower jaw and tongue forward during sleep.	Patients with mild temporomandibular joint discomfort or bruxism can usually wear Klearway with ease because comfort of the temporomandibular joint and the dentition over the long term is one of the criteria used to establish the therapeutic jaw position. It has shown to be particularly effective in increasing the size of the velopharynx.
Mandibular Repositioner	Monobloc functional appliance move the mandible forward.	Mandibular repositioning appliances have been used to affect growth, change airway size, and alter the dentition.
PM Positioner	Advance the mandible.	Treatment of snoring and Obstructive sleep apnea.
Snore Guard	Boil and bite appliance- The mandible is positioned 3 mm behind maximum protrusion with a 7 mm opening. The appliance covers the anterior teeth only.	Only for the treatment of snoring.
TheraSnore	Adjustable boil and bite	Treatment of snoring.

	appliance- The appliance is fitted to the patient's centric occlusion and the mandible can be advanced by using the position indicators on the appliance.	
Tongue Retaining Device (TRD)	A custom-made appliance with an anterior bulb that by means of negative pressure, holds the tongue forward during sleep.	The TRD appliance is particularly useful in patients who have a large tongue. It is an effective alternate to a mandibular repositioner in patients with a compromised dentition or who are edentulous.

Table 1: Oral appliances for sleep apnea

Clinical Algorithm for Selecting Oral Appliances for Treatment of Obstructive Sleep Apnea

The following therapy sequence is suggested for the management of oral appliance (OAs) in patients who are being treated for snoring or OSA.³⁸ (Figure. 3)

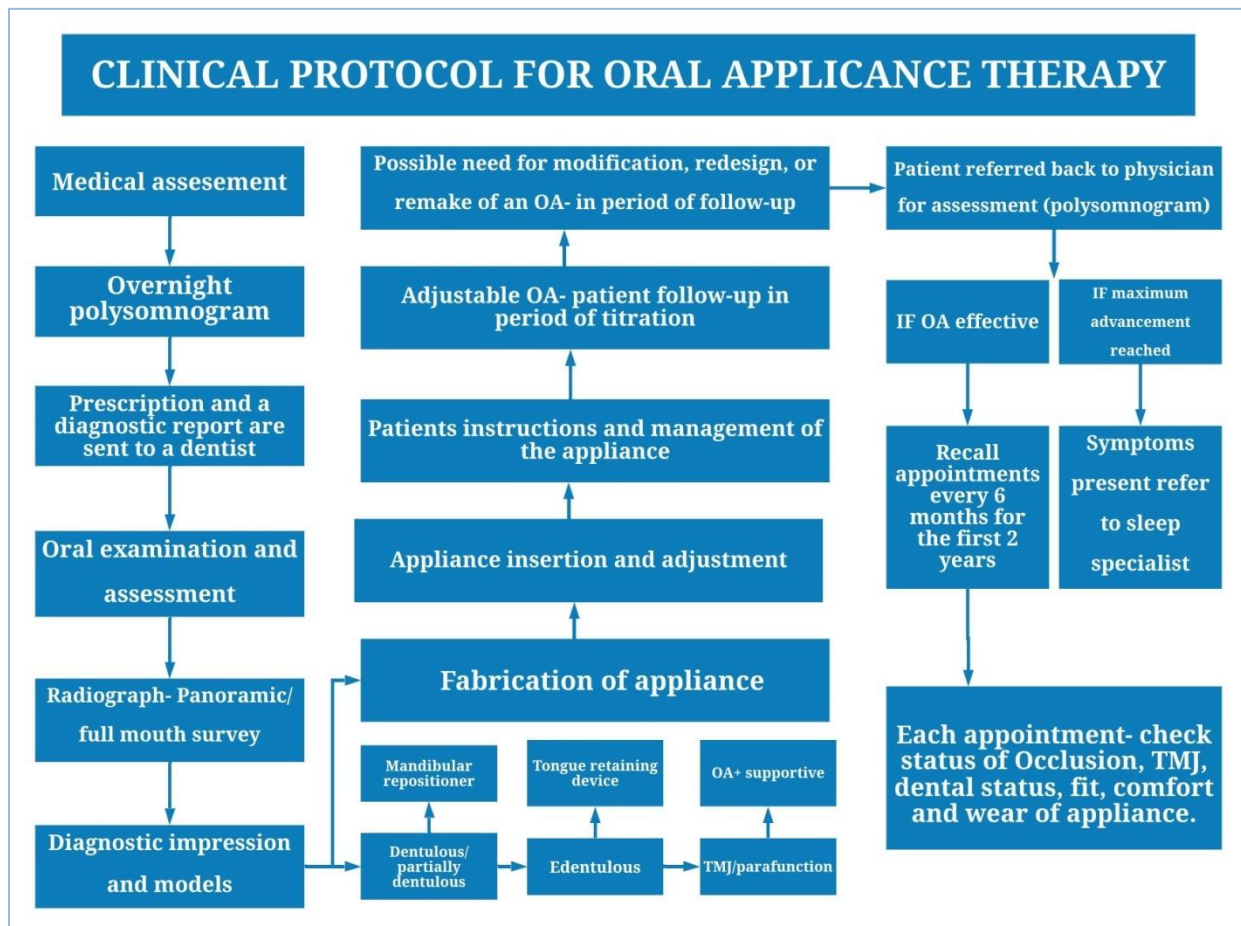


Figure 3: The protocol for management of OSA



Compliance and Adverse Effects

The compliance and side effects of OA treatment might differ depending on the type of the appliance, disease severity, and perhaps patient management. Although compliance is often measured subjectively, Lowe et al used a compliance monitor and their patient cohort wore the OA for a mean of 6.8 hours per night.³⁹ A greater percentage of noncompliance in patients is seen in the first 6 months, which has been reported to be approximately 40%.⁴⁰

Walker-Engstrom ML et al and Nakazawa Y et al reported that the most common reasons to stop using the appliance are discomfort/cumbersome (46%) and no or little effect (36%). Compliance rates vary widely among studies, with a minimum of 4% to a maximum of 82% of compliance after 1 year of treatment.^{41,42} In a study involving 630 patients, Marklund and colleagues described compliance among 75% of the patients after 12 months of treatment.⁴³ After 2 to 5 years of follow-up, studies have shown compliance rates of 48% up to 90%.⁴⁴⁻⁴⁶ Studies with nCPAP have shown that subjective compliance is often higher than objective assessment; therefore, until a compliance monitor is available for OA therapy follow-up, caution should be taken when evaluating OA compliance. The main reasons for discontinuing treatment are reported to be an insufficient reduction of snoring and the presence of side effects.⁴⁰ Most side effects caused by OAs are usually described as mild and transient, and most frequently include dry mouth, excessive salivation, mouth or teeth discomfort, muscle tenderness, and jaw stiffness. Significant and persistent TMJ problems are rare as reported by Marklund et al.⁴³ de Almeida et al used MRI to evaluate the TMJ of seven patients over a mean period of 11 months and concluded that OA in the titrated position seem to be innocuous to the TMJ in patients who have OSA.⁴⁰

Long-term side effects of OA have been recently described by Hamoda et al who reported that tooth movement which leads to occlusal changes is a common side effect of long-term use of OA.⁴⁷ Using a titratable appliance, Almeida and colleagues.^{48,49} showed that OAs used for a mean period of 7.3 years have a significant impact on occlusal and dental structures (example a 2.8 mm decrease in overbite and a 2.6 mm decrease in overjet). Changes which were observed in craniofacial structures were mainly related to significant tooth movements. Marklund et al observed that the frequent use of a monoblock OA with full occlusal coverage for 5 years resulted in median reductions in overjet and overbite of 0.6 mm in patients who had snoring and OSA.⁵⁰ Infrequent users had smaller bite changes. Overjet decreased during the first and second halves of the treatment period, and overbite changes diminished with time.

Conclusion: Older adults experience gradual changes in their sleep patterns, and it is important to distinguish normal age-related changes in sleep from sleep disorders. Apnoea/Hypopnea index (AHI) should be used by clinicians for assessing the severity of the disorder. Based on the age and status of the dentition one of the following treatment protocols should be followed - In dentate patients a mandibular repositioning device should be recommended. Whereas in edentulous patients a tongue retaining device should be used. However, in patients where a TMJ anomaly or parafunction is noted, oral appliance therapy followed by supportive care should be performed. Timely follow-up should be performed for the patients on appliance therapy. Polysomnography should be done to monitor the progress of the disorder. The patient should be recalled every 6 months for the next two years to monitor the progress of the disorder. In case the symptoms persist, a sleep specialist should be consulted. Timely diagnosis and treatment of sleep-disordered breathing not only improve associated morbidity and mortality but may also enhance the quality of life.

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References

1. Bassiri, A. G., & Guilleminault, C. (2000). Clinical features and evaluation of obstructive sleep apnea-hypopnea syndrome. In M. H. Kryger, T. Roth, and W. C. Dement (Eds.), *Principles and Practice of Sleep Medicine 3rd Edition* (pp. 869-893). Philadelphia, PA: W. B. Saunders Company.
2. Chevrin, R. D. & Guilleminault, C. Obstructive sleep apnea and related disorders. *Neurol Clin* 1996; 14: 583-609. [https://doi.org/10.1016/s0733-8619\(05\)70275-9](https://doi.org/10.1016/s0733-8619(05)70275-9)
3. Jennum P, Sjøel A. Epidemiology of snoring and obstructive sleep apnoea in a Danish population, age 30–60. *J Sleep Res* 1992; 1: 240–244. <https://doi.org/10.1111/j.1365-2869.1992.tb00045.x>
4. Jennum P, Riha RL. Epidemiology of sleep apnoea/hypopnoea syndrome and sleep-disordered breathing. *Eur Respir J* 2009; 33: 907-14. <https://doi.org/10.1183/09031936.00180108>
5. Gislason T, Almqvist M, Eriksson G, Taube A, Boman G. Prevalence of sleep apnea syndrome among Swedish men – an epidemiological study. *J Clin Epidemiol* 1988; 41: 571–576. [https://doi.org/10.1016/0895-4356\(88\)90061-3](https://doi.org/10.1016/0895-4356(88)90061-3)
6. Lowe AA: Treating obstructive sleep apnea: the case for oral appliances. *Am J Orthod Dentofacial Orthop* 2012; 147: 434-440. <https://doi.org/10.1016/j.ajodo.2012.08.004>
7. McNicholas WT, Bonsignore MR and the Management Committee of EU COS ACTION b26. Sleep apnoea as an independent risk factor for cardiovascular disease: current evidence, basic mechanisms and research priorities. *Eur Respir J* 2007; 29: 156-78. <https://doi.org/10.1183/09031936.00027406>
8. Marin JM, Carrizo SJ, Vicente E, Agusti AG. Long-term cardiovascular outcomes in men with obstructive sleep apnoea-hypopnoea with or without treatment with continuous positive airway pressure: an observational study. *Lancet* 2005; 365: 1046- 53. [https://doi.org/10.1016/s0140-6736\(05\)71141-7](https://doi.org/10.1016/s0140-6736(05)71141-7)
9. Sharit J. Perspectives on computer aiding in cognitive work domains: toward predictions of effectiveness and use. *Ergonomics* 2003; 46: 126–40. <https://doi.org/10.1080/00140130303533>
10. Pagel JF. The burden of obstructive sleep apnea and associated excessive sleepiness. *J Fam Pract* 2008; 57: S3-8. <https://pubmed.ncbi.nlm.nih.gov/18687237/>
11. Bornstein SK. Respiration during sleep: polysomnography. In: Guilleminault C, editor. *Sleep and waking disorders: indications and techniques*. Menlo Park (CA): Addison- Wesley; 1982: 183.
12. Tiner BD, Waite, PD. Surgical and nonsurgical management of obstructive sleep apnea. In: Peterson LJ, Indresano AT, Marciani RD, Roser SM. *Principles of oral and maxillofacial surgery*. Vol. 3. Philadelphia (PA): J.B. Lippincott Company; 1992.
13. Barewal RM, Hagen CC: Management of snoring and obstructive sleep apnea with mandibular repositioning appliances: a prosthodontic approach. *Dent Clin North Am* 2014; 58:159-180 <https://doi.org/10.1016/j.cden.2013.09.010>
14. Schwab RJ, Goldberg AN. Upper airway assessment: radiographic and other imaging techniques. *Otolaryngol Clin North Am* 1998; 31: 931–68. [https://doi.org/10.1016/s0030-6665\(05\)70100-6](https://doi.org/10.1016/s0030-6665(05)70100-6)
15. Schwab RJ. Upper airway imaging. *Clin Chest Med* 1998; 19: 33–54. [https://doi.org/10.1016/s0272-5231\(05\)70430-5](https://doi.org/10.1016/s0272-5231(05)70430-5)
16. Sharit J. Perspectives on computer aiding in cognitive work domains: toward predictions of effectiveness and use. *Ergonomics* 2003; 46: 126–40. <https://doi.org/10.1080/00140130303533>
17. Martinez-Garcia MA, Campos-Rodriguez F, Catalan-Serra P, et al. Cardiovascular mortality in obstructive sleep apnea in the elderly: role of long-term continuous positive airway pressure treatment: a prospective observational study. *Am J Respir Crit Care Med* 2012; 186: 909–16. <https://doi.org/10.1164/rccm.201203-0448oc>



18. Jennum P, Tonnesen P, Ibsen R, et al. Obstructive sleep apnea: effect of comorbidities and positive airway pressure on all-cause mortality. *Sleep Med* 2017; 36: 62–6. <https://doi.org/10.1016/j.sleep.2017.04.018>
19. Kolanis S, Pilavakis M, Sofogianni A, et al. Is there a role for continuous positive airway pressure treatment in the management of obstructive sleep apnea-related hypertension? *CurrHypertens Rev* 2017; 13: 89–92. <https://doi.org/10.2174/1573402113666170612094750>
20. Bratton DJ, Gaisl T, Schlatzer C, et al. Comparison of the effects of continuous positive airway pressure and mandibular advancement devices on sleepiness in patients with obstructive sleep apnoea: a network meta-analysis. *Lancet Respir Med* 2015; 3: 869–78. [https://doi.org/10.1016/s2213-2600\(15\)00416-6](https://doi.org/10.1016/s2213-2600(15)00416-6)
21. Marklund M, Franklin KA. Treatment of elderly patients with snoring and obstructive sleep apnea using a mandibular advancement device. *Sleep Breath* 2015; 19: 403–5. <https://doi.org/10.1007/s11325-014-0987-8>
22. Wakefield TL, Lam DJ, Ishman SL. Sleep apnea and sleep disorders. In: Flint PW, Haughey BH, Lund VJ, et al, editors. *Cummings otolaryngology–head and neck surgery*. Philadelphia: Elsevier; 2014. p. 252–70.
23. Sommer JU, Hormann K. Innovative surgery for obstructive sleep apnea: nerve stimulator. *Adv Otorhinolaryngol* 2017; 80: 116–24. <https://doi.org/10.1159/000470880>
24. Strollo Jr PJ, Soose RJ, Maurer JT, De Vries N, Cornelius J, Froymovich O, Hanson RD, Padhya TA, Steward DL, Gillespie MB, Woodson BT. Upper-airway stimulation for obstructive sleep apnea. *N. Engl. J. Med.* 2014; 370: 139-49. <https://doi.org/10.1056/nejmoa1308659>
25. Lin J, Suurna M. Sleep apnea and sleep-disordered breathing. *Otolaryng Clin N Am* 2018; 51: 827-33. <https://doi.org/10.1016/j.otc.2018.03.009>
26. Sullivan CE, Issa FG, Berthon-Jones M: Reversal of obstructive sleep apnea by continuous positive airway pressure applied through the nares. *Lancet*: 1981; 317:862-5. [https://doi.org/10.1016/s0140-6736\(81\)92140-1](https://doi.org/10.1016/s0140-6736(81)92140-1)
27. Sullivan CE, Berthon-Jones M, Issa FG: Remission of severe obesity-hypoventilation syndrome after short-term treatment during sleep with nasal continuous positive airway pressure. *Am Rev Respir Dis.* 1983; 128: 177-81. <https://doi.org/10.1164/arrd.1983.128.1.177>
28. Hoffstein V, Viner S, Mateika S: Treatment of obstructive sleep, apnea with nasal continuous positive airway pressure. *Am Rev Respir Dis.* 1992; 145: 841. https://doi.org/10.1164/ajrccm/145.4_pt_1.841
29. Thornton Wk, Roberts H. Nonsurgical management of the obstructive sleep apnea patient. *J Oral Maxillofac Surg.* 1996; 54: 1103-8. [https://doi.org/10.1016/s0278-2391\(96\)90170-6](https://doi.org/10.1016/s0278-2391(96)90170-6)
30. Sullivan CE, Issa FG: Obstructive sleep apnea. *Clin Chest Med* 1985; 6: 633. <https://pubmed.ncbi.nlm.nih.gov/3936665/>
31. Rauscher H, Popp W, Wanke T: Acceptance of CPAP therapy for sleep apnea. *Chest* 1991; 100: 1019-1023. <https://doi.org/10.1378/chest.100.4.1019>
32. Skomro RP, Cotton DJ, Gjevre JA, Grover VK, McNab BD, Reid JK, Ward HA. An empirical continuous positive airway pressure trial for suspected obstructive sleep apnea. *Can Respir J*2007; 1; 14. <https://doi.org/10.1155/2007/397984>
33. Eveloff SE, Rosenberg CL, Carlisle CC, Millman RP. Efficacy of a Herbst mandibular advancement device in obstructive sleep apnea. *Am J Respir Crit Care Med* 1994; 149: 905-9. <https://doi.org/10.1164/ajrccm.149.4.8143054>
34. Lowe AA. Titratable oral appliances for the treatment of snoring and obstructive sleep apnea. *J Can Dent Assoc* 1999; 65:571-4. <https://pubmed.ncbi.nlm.nih.gov/10612935/>



35. Bonham PE, Currier GF, Orr WC, Othman J, Nanda RS. The effect of a modified functional appliance on obstructive sleep apnea. *Am J Orthod Dentofacial Orthop* 1988; 94:384-92. [https://doi.org/10.1016/0889-5406\(88\)90127-8](https://doi.org/10.1016/0889-5406(88)90127-8)
36. Giannasi LC, de Mattos LC, Magini M, Costa S, de Oliveira CS, de Oliveira LV. The impact of the adjustable PM positioner appliance in the treatment of obstructive sleep apnea. *Arch Med Sci* 2008; 4:336-41. <https://www.proquest.com/openview/676d32f208fa02669739df4afe45cf86/1?pq-origsite=gscholar&cbl=696359>
37. Cartwright RD, Samelson CF. The effects of a nonsurgical treatment for obstructive sleep apnea: The tongue retaining device. *JAMA* 1982; 248:705-9. <https://pubmed.ncbi.nlm.nih.gov/7097922/>
38. Almeida FR, Lowe AA. Principles of oral appliance therapy for the management of snoring and sleep disordered breathing. *Oral Maxillofac Surg Clin North Am.* 2009; 21: 413-20. <https://doi.org/10.1016/j.coms.2009.07.002>
39. Lowe AA, Sjolholm TT, Ryan CF, et al. Treatment, airway and compliance effects of a titratable oral appliance. *Sleep* 2000; 23: S172-8. <https://pubmed.ncbi.nlm.nih.gov/10893096/>
40. de Almeida FR, Lowe AA, Tsuiki S, et al. Long-term compliance and side effects of oral appliances used for the treatment of snoring and obstructive sleep apnea syndrome. *J Clin Sleep Med* 2005; 1: 143-52. <https://pubmed.ncbi.nlm.nih.gov/17561628/>
41. Walker-Engstrom ML, Wilhelmsson B, Tegelberg A, et al. Quality of life assessment of treatment with dental appliance or UPPP in patients with mild to moderate obstructive sleep apnoea. A prospective randomized 1-year follow-up study. *J Sleep Res* 2000; 9: 303-8. <https://doi.org/10.1046/j.1365-2869.2000.00210.x>
42. Nakazawa Y, Sakamoto T, Yasutake R, et al. Treatment of sleep apnea with prosthetic mandibular advancement (PMA). *Sleep* 1992; 15: 499-504. <https://doi.org/10.1093/sleep/15.6.499>
43. Marklund M, Stenlund H, Franklin KA. Mandibular advancement devices in 630 men and women with obstructive sleep apnea and snoring: tolerability and predictors of treatment success. *Chest* 2004; 125: 1270-8. <https://doi.org/10.1378/chest.125.4.1270>
44. Yoshida K. Effects of a mandibular advancement device for the treatment of sleep apnea syndrome and snoring on respiratory function and sleep quality. *Cranio* 2000; 18: 98-105. <https://doi.org/10.1080/08869634.2000.11746120>
45. Clark GT, Sohn JW, Hong CN. Treating obstructive sleep apnea and snoring: assessment of an anterior mandibular positioning device. *J Am Dent Assoc* 2000; 131: 765-71. <https://doi.org/10.14219/jada.archive.2000.0275>
46. Marklund M, Sahlin C, Stenlund H, et al. Mandibular advancement device in patients with obstructive sleep apnea: long-term effects on apnea and sleep. *Chest* 2001; 120: 162-9. <https://doi.org/10.1378/chest.120.1.162>
47. Hamoda MM, Almeida FR, Pliska BT. Long-term side effects of sleep apnea treatment with oral appliances: Nature, magnitude and predictors of long-term changes. *Sleep Med.* 2019; 56:184-91. <https://doi.org/10.1016/j.sleep.2018.12.012>
48. Almeida FR, Lowe AA, Otsuka R, et al. Long-term sequelae of oral appliance therapy in obstructive sleep apnea patients: part 2. Study-model analysis. *Am J Orthod Dentofacial Orthop* 2006; 129: 205-13. <https://doi.org/10.1016/j.ajodo.2005.04.034>
49. Almeida FR, Lowe AA, Sung JO, et al. Long-term sequelae of oral appliance therapy in obstructive sleep apnea patients: part 1. Cephalometric analysis. *Am J Orthod Dentofacial Orthop* 2006; 129: 195-204. <https://doi.org/10.1016/j.ajodo.2005.10.001>



50. Marklund M. Predictors of long-term orthodontic side effects from mandibular advancement devices in patients with snoring and obstructive sleep apnea. *Am J Orthod Dentofacial Orthop* 2006; 129: 214–21. <https://doi.org/10.1016/j.ajodo.2005.10.004>

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