Obstructive Sleep Apnea: The Expanding Role of Dentistry In Diagnosis And Treatment

Navdeep Kaur [1], Georgy Jacob [2], Genesis Hurtado [3], Maysan Siddeeq [4], Roseneel Atreya [5], Minu Anna Emmanuel [6]

[1]*BDS, GDip Ops Mgt (NZ), Amritsar, Punjab, India. 23kaurnavdeep@gmail.com*
[2]*BDS, CHIM (Canada), Kochi, Kerala, India. georgyjacobdvg@gmail.com*
[3]*DDS, Caracas, Capital District, Venezuela. oksmez9@gmail.com*
[4]*BDS, Oral and Maxillofacial Dept. Tel Aviv Souraski Medical Center, Israel. Maysan.s.92@gmail.com*
[5]*BDS, Muzaffarnagar, Uttar Pradesh, India. roseneel.dentalclinic@gmail.com*
[6]*BDS, Ernakulam, Kerala, India. minuannaemmanuel1@gmail.com*

KEYWORDS

Obstructive Sleep Apnea (OSA), Oral Appliance Therapy (OAT), Mandibular Advancement Devices (MADs), Continuous Positive Airway Pressure (CPAP), Maxillomandibular Advancement (MMA)

ABSTRACT:

Obstructive Sleep Apnea (OSA) is a prevalent condition characterized by upper airway collapse during sleep, leading to hypoxia and systemic complications such as cardiovascular diseases and metabolic disorders. Dentists are uniquely positioned to diagnose and manage OSA due to their routine access to patients and ability to identify oral and craniofacial risk factors. This comprehensive review explores the intersection of dentistry and OSA, emphasizing structural, functional, and systemic factors contributing to the condition. Oral manifestations like bruxism, xerostomia, and periodontal disease are highlighted as critical diagnostic markers.

The review delves into the gold-standard treatment of Continuous Positive Airway Pressure (CPAP), alongside alternative therapies like Oral Appliance Therapy (OAT) and surgical interventions such as Maxillomandibular Advancement (MMA) and Uvulopalatopharyngoplasty (UPPP). A detailed discussion on the efficacy and patient compliance of CPAP versus mandibular advancement devices offers practical insights into personalized treatment plans. Preventive measures, including lifestyle modifications and early screening tools like the STOP-Bang questionnaire, underscore the pivotal role of dentists in interdisciplinary care. By addressing both oral and systemic implications of OSA, this review advocates for a collaborative, patient-centered approach to improve outcomes.

Introduction

Obstructive Sleep Apnea (OSA) is a disorder marked by the collapse of the upper airway during sleep, leading to intermittent hypopnea and apnea. These disruptions result in decreased oxygen saturation and autonomic dysregulation, which can cause chronic issues in cardiovascular, pulmonary, and neurocognitive systems over the time.[1,2,3]

The condition is more common in men, with a male-to-female prevalence ratio of 1.5:1, with nearly 1 billion people affected globally. However, its prevalence rises in postmenopausal women due to factors like body fat redistribution and decreased hormone protection.[4,5] Epidemiological studies show the risk correlates with body mass index (BMI), as increased fat tissue can narrow the upper airway.[6] The prevalence of OSA rises with age, particularly in individuals over 65.[7] OSA is increasingly recognized as a contributor to cardiovascular morbidity, including systemic and pulmonary hypertension, heart failure, and arrhythmias.[2,3]

While the condition is widely recognized for its systemic impacts, its oral manifestations and risk factors also play a pivotal role in its diagnosis and management. Dentists are uniquely positioned to identify these indicators, facilitating early intervention and comprehensive care. The following are the key risk factors contributing to OSA and its extensive oral and systemic implications:

Oral Risk Factors Contributing To Obstructive Sleep Apnea

1. Craniofacial and Structural Risk Factors

Several craniofacial features predispose individuals to OSA by reducing airway space and increasing resistance. These include:

- **Retrognathic Mandible**: A backward-positioned lower jaw restricts the airway, creating a narrower passage for airflow during sleep.[8,9]
- **High-Arched Palate and Narrow Dental Arches**: These structural anomalies limit the oral cavity's capacity, increasing the likelihood of airway obstruction.[8,9]
- **Malocclusions**: Irregular bite alignments such as posterior crossbites and anterior open bites alter jaw positioning, further compounding airway resistance.[8,9]

2. Enlarged Oral and Pharyngeal Structures

- **Macroglossia (Enlarged Tongue)**: A large tongue occupies excessive space within the oral cavity, obstructing airflow during sleep. A scalloped tongue, characterized by indentations along the edges caused by pressure against the teeth, often accompanies macroglossia and indicates limited oral cavity space.[8,9]
- **Hypertrophied Tonsils and Adenoids**: In children, enlarged tonsils and adenoids are primary contributors to OSA, narrowing the upper airway and disrupting sleep.[8,9]

3. Functional Risk Factors

Functional contributors to OSA primarily involve airflow challenges and oral habits:

- **Mouth Breathing**: Commonly linked to nasal obstruction, chronic mouth breathing increases the risk of airway collapse and contributes to xerostomia, caries, and periodontal disease.[8,9]
- The **Friedman Tongue Position (FTP)**, also known as the **modified Mallampati index**, is a refined adaptation of the traditional Mallampati score (Table 1). It evaluates the tongue's natural position without protrusion, offering a more physiological assessment akin to its posture during sleep. Higher FTP grades (3 and 4) indicate significant oropharyngeal crowding and are associated with increased risk of obstructive sleep apnea (OSA) due to potential airway obstruction.[10]

FTP Grade	Description	Associated Risk of OSA
Grade 1	Complete visualization of the uvula, tonsils, and palatal arches	Low risk; minimal oropharyngeal crowding
Grade 2	Partial visualization of the uvula, pillars, and upper pole	Moderate risk; some oropharyngeal crowding
Grade 3	Only part of the soft palate visible; tonsils, pillars, and uvula base obscured	High risk; significant oropharyngeal crowding with posterior tongue collapse during sleep
Grade 4	Only the hard palate is visible	Very high risk; severe oropharyngeal crowding indicating substantial airway obstruction potential

Table 1: Friedman Tongue Position (FTP) Classification and Associated Risk of Obstructive Sleep Apnea (OSA)

Regular oral evaluations help identify these risk factors, providing actionable insights for OSA management.

4. Lifestyle and Systemic Risk Factors

Lifestyle choices and systemic health conditions also influence OSA risk:

- **Obesity**: Excess fat deposits around the neck and upper airway exacerbate airway narrowing, making obesity one of the strongest predictors of OSA.[8,9]

- **Diet and Sedentary Lifestyle**: High-calorie diets and physical inactivity contribute to weight gain, indirectly increasing OSA severity.[8,9]

Addressing these modifiable risk factors through lifestyle interventions can significantly reduce OSA severity and its associated complications. These findings highlight the need for collaborative care between dentists and medical professionals to address airway-related anatomical concerns.

Oral Implications Of Obstructive Sleep Apnea

1. Bruxism and Temporomandibular Disorders (TMD)

Bruxism, a parafunctional activity often observed in OSA patients, results from repetitive jaw movements aimed at maintaining airway patency during apneic events. This excessive occlusal loading contributes to enamel attrition, microfractures, and hypersensitivity, while also placing strain on the temporomandibular joint (TMJ). Dentists can identify TMD through signs like restricted mandibular mobility, joint clicking, and myofascial pain, which are exacerbated by nocturnal clenching.[8,9]

2. Xerostomia and Dental Caries

Xerostomia is prevalent in OSA patients, primarily due to mouth breathing caused by nasal obstruction. This reduction in salivary flow compromises the oral cavity's defense mechanisms, including acid neutralization and antimicrobial action, resulting in an increased risk of dental caries and opportunistic infections like candidiasis. Clinical signs such as desiccated oral mucosa, cracked lips, and fissured tongues provide diagnostic clues for dentists during routine examinations.[8,9]

3. Periodontal Disease

OSA's systemic inflammatory response is closely linked to periodontal disease. Intermittent hypoxia and oxidative stress elevate levels of pro-inflammatory cytokines (IL-1β, IL-6, and TNF-α), intensifying periodontal tissue destruction. Radiographic findings in OSA patients often reveal advanced alveolar bone loss, while clinical presentations include deep periodontal pockets, gingival bleeding, and attachment loss.[8,9]

4. Craniofacial and Dental Morphology

Craniofacial structures such as a retrognathic mandible or a high-arched palate are anatomical risk factors for OSA, as they reduce oropharyngeal space and increase airway resistance. Dentists can identify these anomalies during routine occlusal and skeletal evaluations, often observing malocclusions such as posterior crossbites or anterior open bites. Additionally, mandibular advancement devices (MADs) used in OSA management can lead to changes in dental alignment, requiring careful monitoring.[8,9]

5. Palatal Changes and Associated Conditions

OSA patients frequently present with soft palate hypertrophy and a constricted hard palate, which reduce airway patency. These conditions contribute to chronic mouth breathing, reinforcing a cycle of xerostomia and dental complications. Cone-beam computed tomography (CBCT) can assist in evaluating palatal morphology and its impact on airway function, allowing dentists to identify and address structural contributors to OSA.[8,9]

6. Taste Alterations

OSA-associated intermittent hypoxia disrupts gustatory neural pathways, impairing taste perception and altering dietary preferences. These changes often lead to increased consumption of sugary foods, which exacerbate caries risk. Additionally, taste receptor dysfunction can reduce salivary stimulation, further aggravating xerostomia and its associated complications.[8,9]

Systemic Implications of OSA

OSA is increasingly recognized as a systemic disease due to its widespread impacts on metabolic and cardiovascular health. Intermittent hypoxia and sleep fragmentation caused by OSA trigger oxidative stress and systemic inflammation. These mechanisms contribute to endothelial

dysfunction, hypertension, coronary artery disease, and arrhythmias, significantly increasing the risk of cardiovascular events such as myocardial infarction and stroke. Additionally, OSA is strongly associated with insulin resistance, Type 2 diabetes, and dyslipidemia, exacerbating the metabolic syndrome. Addressing OSA through treatments like CPAP/APAP (Auto-titrating Positive Airway Pressure) can improve systemic health outcomes and reduce associated risks.[11]

Diagnosis And Role Of Dentists In The Management Of Obstructive Sleep Apnea (OSA)

Dentists, due to their regular interactions with patients, can help recognize physical and anatomical indicators and risk factors of OSA. Dentists can also use screening tools and questionnaires to assess the risk of Obstructive Sleep Apnea Syndrome (OSAS) and refer patients for further evaluation, such as polysomnography, conducted by sleep specialists. Early identification is crucial in addressing the issue of underdiagnosed OSAS. Commonly used OSAS questionnaires include:

- **Epworth Sleepiness Scale (ESS):** Measures daytime sleepiness to assess sleep disorders.[12]
- **STOP-BANG Questionnaire:** Evaluates risk factors like snoring, tiredness, observed apnea, high blood pressure, BMI, age, neck circumference, and gender.[12]
- **Berlin Questionnaire:** Assesses snoring, fatigue, and medical history to classify the risk of OSAS.[12]

By recognizing these markers and using validated screening tools, dentists can refer patients for timely evaluation, ensuring prompt diagnosis and treatment.[12]

Common OSA symptoms include snoring, apnea, arousals, and daytime sleepiness, though these are not diagnostic. A correct diagnosis of OSAS requires a thorough anamnesis, including family history (OSAS), personal history (tonsillectomy/adenoidectomy, alcohol use, muscle relaxants, obesity), and physical examination (assessment of height, weight, body mass index, cardiovascular health, and the upper airway -nasal passages, oropharynx, hypopharynx, and larynx) in conjunction with a comprehensive sleep evaluation and adequate follow up. Diagnosis is confirmed by polysomnography (PSG) which is the standard diagnostic test of OSA in adult patients.[13] PSG is typically conducted overnight and monitors sleep stages, respiration, electrocardiogram (ECG), eye and leg movements, oxygen levels, heart rate and snoring. PSG also calculates the apnea-hypopnea index (AHI) which is considered an important respiratory event monitored to determine the severity of OSA. AHI is defined as total number of apnea and hypopnea events divided by the number of hours of sleep documented during PSG, where Apneas are defined as respiratory events with ≥90% reduction in airflow for ≥10 s (with no requirement for a desaturation or an arousal), whereas, hypopneas as events with ≥30% reduction in airflow for ≥10 s and ≥3% oxygen desaturation or an associated electroencephalogram (EEG, cortical) arousal. Adult OSA is accordingly classified as None (AHI, i.e., events/ hour <5), Mild (AHI ≥5 to <15), Moderate (AHI ≥15 to <30), and Severe (≥30). [13,14]

Dentists play a crucial role in early screening and in maintaining airway patency during sleep, including pediatric patients through assistance with early intervention, such as palatal expansion and functional appliances to promote proper jaw development and reduce the likelihood of developing OSAS later in life.[12] Radiological studies, such as lateral or 3D X-rays, can identify craniofacial abnormalities that predispose individuals to OSAS.[13] This highlights the importance of collaborative care and an interdisciplinary approach in managing OSAS, addressing both structural and developmental factors.[12]

General dentists, orthodontists, and maxillofacial surgeons can play key roles in management of OSAS, through appliance therapy and surgical interventions such as maxillomandibular advancement (MMA) surgery, genioglossus advancement to address tongue-related issues, and uvulopalatopharyngoplasty (UPPP) to remove tissue from specific blockage sites.

Gold Standard Of OSA Treatment- CPAP And APAP

Continuous Positive Airway Pressure (CPAP) is the gold standard for treating sleep apnea.[15] The process involves delivering a continuous stream of pressurized air through a mask keeping the patient airways open as they sleep.[16] However, it has poor compliance and tolerance in 30-50% of patients due to discomfort.[17] Auto-titrating Positive Airway Pressure (APAP) is a common variation that adjusts pressure based on changes in airflow resistance, which can vary with factors like posture and nasal congestion. This adaptive pressure is believed to enhance comfort and improve patient compliance. A 2009 Cochrane review found APAP to be slightly more effective than CPAP in improving compliance.[18]

Although APAP and CPAP were similar in short-term effects on AHI, quality of life, and sleep study measures in patients with moderate to severe obstructive sleep apnea (OSA) without major comorbidities, APAP reduced sleepiness by about 0.5 points on the Epworth Sleepiness Scale (ESS) and showed 11 minutes more compliance per night compared to fixed CPAP. However, the choice between APAP and CPAP should be based on individual patient preferences, reasons for non-compliance, costs, and practical factors.[19]

In dental settings, sedation for OSA is limited due to the risk of hypoxia. Anesthesiologists prefer not to give any sedative to patients with OSA or support the use of general anesthesia due to good airway control. However, depending on the case, it is possible to sedate a dental patient with OSA using intraoperative CPAP without causing hypoxia. Combining sedation with CPAP is though considered after a further evaluation and only if the effectiveness of home CPAP therapy has been proven.[20]

Oral Appliance Therapy (OAT)

Another most used therapy to treat OSA accepted as effective alternative to CPAP in mild to moderate OSA except for extremely and morbidly obese persons, is Oral Appliance Therapy (OAT).[15,17] Even though OAT have lower efficacy than CPAP, patients have superior adherence to OAT compared to CPAP.[17] Thus, American Academy of Sleep Medicine clinical practice guidelines recommend the use of OAT in patients who are noncompliant to CPAP.[21]

Mode of Action

OAT is a non-invasive treatment that can help reduce the severity and frequency of apneas and hypoxia during sleep by bringing anatomic, muscular, and functional changes. The primary mode of action of Appliances involves displacement of the mandible in an anterior and forward direction along with the anterior displacement of tongue, thereby increasing the size of pharyngeal airway and keeping it open during sleep. There is an increase in the post-lingual and post-palatal airway spaces, as well as an increase in the lateral airway dimension which causes significant improvement in Obstructive Sleep Apnea in response to OAT. In addition, OAT can also improve muscle tone around the airway by repositioning the jaw and tongue, further decreasing the likelihood of obstruction during sleep.[15]

Types of OAT

OAT can be classified into Custom- made and Noncustom (boil and bite) devices.[15] Custom- made OAT are the treatment of choice as they are more effective and retentive and thus better tolerated and preferred by patients.[15,21] These devices are made from a physical impression or digital scan of the teeth and are manufactured as monobloc (single appliance with a pre-determined degree of mandibular protrusion), or dual appliance (separate maxillary and mandible components with a locking mechanism to allow adjustments for mandibular advancement as may be required). Noncustom OAT are prefabricated and offer limited to no scope of adjustment for mandibular protrusion.[15]

OAT nomenclature ranges from mandibular advancement splints/ mandibular advancement devices/ mandibular advancement appliances, through to mandibular repositioning appliances or

mandibular repositioning devices.[15,17,21] As per the OAT definition accepted by the American Academy of Dental Sleep Medicine (AADSM), sleep appliances are the Mandibular Advancement Devices (MAD) .[22]

Mandibular Advancement Devices (MADs)

Mandibular Advancement Devices (MADs) represent a primary orthodontic approach to address OSA. By pushing the lower jaw and attached mandibular teeth forward slightly. MADs are applied through the mandibular arch, rather than the maxillary teeth. These devices usually allow dental and soft tissue modifications and can be individually personalized as per the patient needs.[23]

Other than MADs, some of the other oral appliances that can be used to treat OSA are:

Tongue-Retaining Devices (TRDs)

TRD is an orthodontic device that retains the tongue. Studies have shown that this orthodontic appliance can improve airflow parameters and decrease the severity of apnea by reducing the degree of obstruction of the upper respiratory pathway. Designed specifically to position the tongue forward, the function of this appliance distinguishes it from other orthodontic appliances that were designed to increase the dimension of the upper respiratory airway by repositioning the jaws. The compliance of long-term use depends on the patient's comfort with the appliance in the mouth. A patient who chooses to use a TRD may experience discomfort and difficulty speaking in the first week. This feeling tends to disappear slowly, and patients adjust to this discomfort after about 2 to 4 weeks, however, it may differ from patient to patient.[24]

Palatal Expanders

Palatal expansion is an orthodontic appliance that expands the airway space, particularly for sleep apnea in children. It gradually opens the midline suture and expands dense palatal bones, increasing the nasal respiratory chamber's volume and improving nasal breathing. Besides addressing maxillary narrowing, compression, and cross-bite issues, palatal expanders can assist with class 2 facial cases. This procedure influences mastication, deglutition, and facial and respiratory functions. Additionally, palatal expansion may widen the lateral airway and is supported by posterior bone under the maxilla, which aids nasal muscle function.[25]

Since Oral Appliance Therapy involves a long duration of treatment, there can be some potential side effects like occlusal changes, Temporomandibular Joint pain, muscle pain, soft tissue irritation, dry mouth, excessive salivation, and appliance related anxiety, etc. However, these can be minimized by practicing conservative titration by advancing the appliance minimally so that it is just enough to manage the OSA, and the concurrent use of a morning occlusal guide. Regular follow ups and adjustments are also required to ensure the appliance is working effectively. [21]

Surgical Approaches For The Treatment Of OSA

In the treatment of obstructive sleep apnea (OSA), surgical intervention is considered when conventional therapies fall short or are not favored by the patient. In contrast to a range of orthodontic devices, surgical procedures generally provide more durable results and can significantly enhance an individual's overall well-being. The primary aim of these surgeries is to alleviate or reduce the constriction in the upper airway. This is achieved by removing the tissue responsible for the obstruction, tightening structures within the throat or larynx, or even expanding the space within the throat to facilitate better airflow.[26]

Uvulopalatopharyngoplasty (UPPP)

Uvulopalatopharyngoplasty (UPPP) is one of the surgical procedures employed to treat obstructive sleep apnea (OSA). UPPP is done by removing excess throat tissue to make the airway wider in the throat. The palate is cut, and the uvula and small parts of the soft palate are removed. Indications for UPPP therapy include anyone who has obstructive sleep apnea, as it moves the muscle and removes the tissues that obstruct the airway, which may be difficult to address with

other nonsurgical methods. Patients who have sleep apnea due to sinuses that are too small or throat and facial bones that restrict the airway can benefit from UPPP.[27]

Maxillomandibular Advancement (MMA)

Also known as maxillomandibular advancement, this technique is a hard tissue moving method and an anatomical treatment for obstructive sleep apnea. The surgical approach has three main types. The conventional one-stage operation consists of bimaxillary surgery, which offers better stability but may be more traumatic as it involves a single session. Current indications include a compromised airway with an anteroposterior section of at least 10 mm. Studies show significant improvements in the apnea-hypopnea index post-surgery, along with a better quality of life and cessation of CPAP use, although some patients may not experience natural breathing improvement. Surgical risks include paresthesia of the inferior alveolar nerve, changes in facial appearance, occlusal issues, and post-operative discomfort. Long-term results of this surgical technique show a consistent resolution of apnea and overall morbidity.[28]

Tracheostomy

Tracheostomy, first noted by Jackson in 1909, has been used in treating obstructive sleep apnea (OSA) by surgically creating an airway opening in the neck that bypasses the obstruction in the upper airway. This procedure ensures airflow directly to the lungs, enabling patients to breathe despite upper airway blockages. The stoma created is permanent, and the procedure is typically indicated for significant, life-threatening apnea when other treatments have failed. Tracheostomy can be lifesaving, leading to immediate improvements in airway function, and notably reduces the Apnea-Hypopnea Index (AHI), enhancing overall quality of life—more restful sleep, reduced snoring, and alleviated symptoms like dry mouth and fatigue.[29]

Prevention And Education

Dentistry has an important role in combating OSA through prevention, education, and interdisciplinary collaboration. By leveraging their expertise in oral health and airway anatomy, dental professionals can help reduce the burden of this underdiagnosed disorder. Strengthening training programs and fostering collaboration with other healthcare providers will enhance the role of dentistry in OSA management and prevention.[30]

Early Identification and Screening

Dentists can observe structural features that suggest a higher likelihood of OSA, such as a recessed jaw, enlarged tonsils, or a narrow palate, during routine dental exams. These findings, paired with patient-reported symptoms like snoring or disrupted sleep, can prompt further investigation.[29,30] Tools such as the STOP-Bang questionnaire and the Epworth Sleepiness Scale help identify high-risk individuals, who may then be referred for a comprehensive sleep study.[30]

Dental manifestations like bruxism, enamel wear, dry mouth, erythema of the soft palate, an elongated uvula, and hypertrophied tongue tissue can also be indicative of sleep-disordered breathing.[30] By examining these signs in conjunction with a patient's medical and sleep history, dentists can play a pivotal role in bridging the gap between oral health and sleep medicine. Patients presenting with these issues can be referred to sleep specialists, improving the likelihood of timely diagnosis and intervention.[31]

Collaborative Care and Lifestyle Interventions

Dentists can work collaboratively with medical professionals, including sleep specialists and otolaryngologists, to provide integrated care for OSA patients. Such a multidisciplinary approach ensures a comprehensive treatment strategy that addresses both the structural and behavioral aspects of the condition.[31]

Educating patients about lifestyle changes, such as weight management, avoiding sedative medications, and improving sleep hygiene, further supports prevention and treatment efforts. For

instance, maintaining a side-sleeping position has been shown to alleviate airway obstruction in some patients. Encouraging patients to adopt these behaviors can reduce the severity and impact of OSA.[30]

Public Health Initiatives

Community-based awareness campaigns led by dental and medical professionals can emphasize recognizing key OSA symptoms, such as chronic snoring, daytime fatigue, and frequent awakenings. These efforts often target at-risk populations, such as those with obesity or cardiovascular comorbidities. Through public education, more individuals can become informed about the risks of untreated OSA and seek care earlier.[30]

Conclusion

Dentists play a significant role in the identification, management, and ongoing care of patients with OSA. Their ability to detect early signs of OSA during dental exams underscores their important role as diagnosticians, while their expertise in oral appliance therapy positions them as key contributors to treatment. The use of mandibular advancement devices (MADs) and surgical options like MMA demonstrates that dentists can provide effective alternatives to the gold standard CPAP therapy. By collaborating with sleep specialists, and surgeons, dentists and dental specialists ensure a comprehensive and patient-centered approach to OSA management.[8] This integration bridges the gap between oral health and sleep medicine, promoting early detection, consistent treatment, and improved patient outcomes. A interdisciplinary approach not only enhances the health and quality of life for individuals affected by OSA but also sets a standard for collaborative care in addressing this complex condition.[8,12]

References

1. Abbasi A, Gupta SS, Sabharwal N, Meghrajani V, Sharma S, Kamholz S, et al. A comprehensive review of obstructive sleep apnea. Sleep Sci. 2021;14(2):142-54.
2. Jordan AS, McSharry DG, Malhotra A. Adult obstructive sleep apnoea. Lancet. 2014;383(9918):736-47.
3. Peppard PE, Young T, Barnet JH, Palta M, Hagen EW, Hla KM. Increased prevalence of sleep-disordered breathing in adults. Am J Epidemiol. 2013;177(9):1006-14.
4. Theorell-Haglöw J, Miller CB, Bartlett DJ, Yee BJ, Openshaw HD, Grunstein RR. Gender differences in obstructive sleep apnoea, insomnia and restless legs syndrome in adults: A clinical update. Sleep Med Rev. 2018;38:28-38.
5. Resta O, Bonfitto P, Sabato R, De Pergola G, Foschino Barbaro MP. Prevalence of obstructive sleep apnoea in a sample of obese women: effect of menopause. Diabetes Nutr Metab. 2004;17(5):296-303.
6. Young T, Skatrud J, Peppard PE. Risk factors for obstructive sleep apnea in adults. JAMA. 2004;291(16):2013-6.
7. Stradling J, Davies R. Obstructive sleep apnoea/hypopnoea syndrome: Definitions, epidemiology, and natural history. Thorax. 2004;59(1):73-8.
8. Maniaci A, Lavalle S, Anzalone R, Lo Giudice A, Cocuzza S, Parisi FM, et al. Oral health implications of obstructive sleep apnea: A literature review. Biomedicines. 2024;12(7):1382.
9. Al-Talib T, Chiang H, Pinto A, Hay IM, Park R, Goodman X, et al. Risk factors for OSA observed during orofacial examination: A review. J Dent Sleep Med. 2024;11(2):115-20.
10. Luzzi V, Altieri F, Guaragna M, Pirro V, Marasca B, Cotticelli L, et al. Friedman tongue position and anthropometric parameters in adult patients with obstructive sleep apnea: An observational study. Int J Environ Res Public Health. 2023;20(4):3255.
11. Bonsignore MR, Marrone O, Insalaco G. Obstructive sleep apnea syndrome is a systemic disease: Current evidence. Multidiscip Respir Med. 2019;14:44.
12. Alrejaye NS, Al-Jahda H. Dentists' role in obstructive sleep apnea: A more comprehensive review. Sleep Epidemiol. 2024;4:100073.

13. Azagra-Calero E, Espinar-Escalona E, Barrera-Mora JM, Llamas-Carreras JM, Solano-Reina E. Obstructive sleep apnea syndrome (OSAS). Review of the literature. Med Oral Patol Oral Cir Bucal. 2012;17:e925–e929.
14. Chang JL, et al. International Consensus Statement on Obstructive Sleep Apnea (ICS:OSA). Int Forum Allergy Rhinol. 2023 Jul;13(7):1061-1482.
15. Johal A, Hamoda MM, Almeida FR, Marklund M, Tallamraju H. The role of oral appliance therapy in obstructive sleep apnoea. Eur Respir Rev. 2023;32(168):220257.
16. Ho JJ, Zakarija-Grkovic I, Lok JW, Lim E, Subramaniam P, Leong JJ. Continuous positive airway pressure (CPAP) for apnoea of prematurity. Cochrane Database Syst Rev. 2023;(7):CD013660.
17. Almeida FR, Bansback N. Long-term effectiveness of oral appliance versus CPAP therapy and the emerging importance of understanding patient preferences. Sleep. 2013;36(9):1271-2.
18. Smith I, Lasserson TJ. Pressure modification for improving usage of continuous positive airway pressure machines in adults with obstructive sleep apnoea. Cochrane Database Syst Rev. 2009;(4):CD003531.
19. Ip S, D'Ambrosio C, Patel K, Obadan N, Kitsios GD, Chung M, et al. Auto-titrating versus fixed continuous positive airway pressure for the treatment of obstructive sleep apnea: A systematic review with meta-analyses. Syst Rev. 2012;1:20.
20. Kasatkin AA, Reshetnikov AP, Urakov AL, Baimurzin DY. Continuous Positive Airway Pressure prevents hypoxia in dental patients with obstructive sleep apnea syndrome under intravenous sedation. Anesth Essays Res. 2017;11(2):528-30.
21. Ramar K, Dort LC, Katz SG, Lettieri CJ, Harrod CG, Thomas SM, Chervin RD. Clinical Practice Guideline for the Treatment of Obstructive Sleep Apnea and Snoring with Oral Appliance Therapy: An Update for 2015. J Clin Sleep Med. 2015; pii: jc-00186-15.
22. Alansari RA. The role of orthodontics in management of obstructive sleep apnea. Saudi Dent J. 2022;34(3):194-201.
23. Lo Giudice A, La Rosa S, Palazzo G, Federico C. Diagnostic and therapeutic indications of different types of mandibular advancement design for patients with obstructive sleep apnea syndrome: Indications from literature review and case descriptions. Diagnostics (Basel). 2024;14(17):1915.
24. Alshhrani WM, Hamoda MM, Okuno K, Kohzuka Y, Fleetham JA, Ayas NT, et al. The efficacy of a titrated tongue-stabilizing device on obstructive sleep apnea: A quasi-experimental study. J Clin Sleep Med. 2021;17(8):1607-18.
25. Lima Illescas MV, Aucapiña Aguilar DC, Vallejo Ledesma LP. A review on the influence of rapid maxillary expansion and mandibular advancement for treating obstructive sleep apnea in children. J Clin Pediatr Dent. 2023;47(1):9-16.
26. Gottlieb DJ, Punjabi NM. Diagnosis and management of obstructive sleep apnea: A review. JAMA. 2020;323(14):1389-400.
27. Li HY, Tsai MS, Lee LA, Hsin LJ, Lee YC, Lin WN, et al. Palatal hybrid surgery for obstructive sleep apnea: Annotation of uvulopalatopharyngoplasty. Biomed J. 2022;46(3):100568.
28. Rocha NS, de França AJB, Niño-Sandoval TC, Vasconcelos BC, Laureano Filho JR. Efficiency of maxillomandibular advancement for the treatment of obstructive apnea syndrome: A comprehensive overview of systematic reviews. Clin Oral Investig. 2022;26(6):4291-305.
29. Soltis ME, Spector AR. A concise review of polysomnography and obstructive sleep apnea for the neurophysiologist. J Clin Neurophysiol. 2023;40(3):191-7.
30. Slowik JM, Collen JF. Obstructive sleep apnea: A concise review for clinicians. JAMA. 2018;318(20):2034-46.
31. Berggren K, Broström A, Firestone A, Wright B, Josefsson E, Lindmark U. Oral health problems linked to obstructive sleep apnea are not always recognized within dental care: As described by dental professionals. Clin Exp Dent Res. 2022;8(1):84-95.