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Prosthodontic Management Of Obstructive Sleep Apnea: A Review

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Abstract:
Obstructive Sleep Apnea (OSA) is a prevalent sleep disorder that affects millions of people worldwide, including a significant proportion of the Indian population. While Continuous Positive Airway Pressure (CPAP) therapy remains the gold standard for OSA treatment, oral appliance therapy (OAT) has emerged as a viable alternative or adjunctive treatment option. This review aims to provide an overview of the prosthodontic management of OSA, including the etiology and pathophysiology of the disorder, prosthodontic evaluation and diagnosis, and the various treatment options and clinical considerations involved in OAT. The article also highlights the importance of a multidisciplinary approach to OSA management and discusses the future directions for research and clinical practice in prosthodontic management of OSA.

Keywords: *Obstructive Sleep Apnea, Prosthodontic Management, Oral Appliance Therapy, Continuous Positive Airway Pressure, Sleep Disorder.*

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I. Introduction

Obstructive Sleep Apnea (OSA) is a pervasive and debilitating sleep disorder characterized by recurring episodes of partial or complete upper airway obstruction during sleep. The prevalence of Obstructive Sleep Apnea (OSA) in Indians is a significant concern. Studies suggest that approximately 93% of Indians are sleep-deprived, and the prevalence of OSA is higher in the western region of India compared to other parts. In terms of numbers, it's estimated that around 104 million Indians of working age may be suffering from OSA, with men being at a higher risk (13%) compared to women (5%) The prevalence of OSA in Indian adults is around 11%, with a higher incidence among men than women. Breaking it down further, the prevalence of high current risk of moderate to severe OSA is around 12.7% in apparently healthy young and middle-aged adults OSA is also more common among Indians who are obese, with a significant positive correlation between OSA risk score and waist-hip ratio, waist-height ratio, and sleep quality scores , OSA is associated with a multitude of systemic health consequences, including cardiovascular disease, diabetes, and cognitive impairment.[1]

While continuous positive airway pressure (CPAP) therapy remains the gold standard for OSA treatment, many patients struggle with adherence due to discomfort, noise, or claustrophobia. In recent years, prosthodontic management has emerged as a viable alternative or adjunctive treatment option for OSA, leveraging oral appliance therapy (OAT) to advance the mandible, stabilize the tongue, and maintain patency of the upper airway. This article aims to provide an overview of the prosthodontic management of OSA, including the etiology and pathophysiology of the disorder, prosthodontic evaluation and diagnosis, and the various treatment options and clinical considerations involved in OAT. By exploring the role of prosthodontics in OSA management, this article seeks to contribute to the growing body of literature on this important topic and enhance the knowledge and skills of prosthodontists and other healthcare professionals involved in the care of patients with OSA.

II. Etiology Of Obstructive Sleep Apnea

Anatomical Factors	Non anatomical Risk Factors	Additional Factors
• Micrognathia and retrognathia • Facial elongation	• Central fat distribution • Obesity	• Alcohol use • Smoking

• Mandibular hypoplasia • Adenoid and tonsillar hypertrophy • Inferior displacement of the hyoid	• Advanced age • Male gender • Supine sleeping position • Pregnancy	• Use of sedatives and hypnotics

Table no.1 Etiology of obstructive sleep apnea

III. Prosthodontic Evaluation And Diagnosis Of OSA

1. Medical History

1. Assess the patient's medical history, including sleep disorders, respiratory problems, and other health conditions.[2] Inquire about symptoms such as snoring, daytime sleepiness, morning headaches, and difficulty concentrating. Review the patient's medications, including sedatives, hypnotics, and opioids, which can exacerbate OSA.

2. Sleep Questionnaires

1. Use standardized sleep questionnaires, such as:

a. Epworth Sleepiness Scale (ESS): assesses daytime sleepiness. **(Figure no.1)**
b. Berlin Questionnaire: evaluates the risk of OSA.
c. STOP-BANG Questionnaire: assesses the risk of OSA.[3] **(Figure no.2)**

These questionnaires can help identify patients who are at high risk for OSA.

Epworth Sleepiness Questionnaire For a Medicare subsidised sleep study a patient must score 8 or more.

How likely are you to doze off in the following situations?	No Chance	Slight Chance	Moderate Chance	High Chance
Sitting and reading	❍ 0	❍ 1	❍ 2	❍ 3
Watching television	❍ 0	❍ 1	❍ 2	❍ 3
Sitting inactive, in a public space	❍ 0	❍ 1	❍ 2	❍ 3
Lying down to rest in the afternoon when circumstances permit	❍ 0	❍ 1	❍ 2	❍ 3
Sitting and talking to someone	❍ 0	❍ 1	❍ 2	❍ 3
Sitting quietly after a lunch without alcohol	❍ 0	❍ 1	❍ 2	❍ 3
As a passenger in a car for an hour without a break	❍ 0	❍ 1	❍ 2	❍ 3
In a car, while stopped for a few minutes in traffic	❍ 0	❍ 1	❍ 2	❍ 3
			TOTAL SCORE:	

Figure no.1 Epwoth sleepiness questionnaire

'STOP BANG' Questionnaire For a Medicare subsidised sleep study a patient must score 4 or more.

Do you **S**nore loudly?	❍ Yes	❍ No
Do you often feel **T**ired?	❍ Yes	❍ No
Has anyone **O**bserved you stop breathing or choking/gasping during your sleep?		
Do you have or are you being treated for high blood **P**ressure?	❍ Yes	❍ No
Is your **B**ody mass index more than 35 kg/m²?	❍ Yes	❍ No
Are you **A**ged older than 50?	❍ Yes	❍ No
Is your **N**eck size: For male 17 inches / 43cm or larger? For female 16 inches / 41cm or larger? (measured around adams apple)	❍ Yes	❍ No
Is your **G**ender male?	❍ Yes	❍ No
TOTAL 'YES' ANSWERS:		

Figure no.2 STOP BANG Questionnaire

3. Intraoral Examination[4]

1. Perform an intraoral examination to assess the patient's oral anatomy, including:

a. Size and position of the tongue.
b. Soft palate length and thickness.

c. Uvula size and shape.
d. Tonsil size and shape.
2. Evaluate the patient's dental occlusion, including:
e. Overbite and overjet.
f. Crossbite and open bite.
3. Assess the patient's oral habits, including:
g. Bruxism.
h. Tooth grinding.

4. Upper Airway Evaluation
1. Evaluate the patient's upper airway using techniques such as:
a. Mallampati classification: assesses the size of the tongue and the oral cavity.
b. Friedman tongue position: assesses the position of the tongue.[5]
2. Use imaging studies, such as:
c. Cephalometric radiographs.
d. Computed tomography (CT) scans.
e. Magnetic resonance imaging (MRI) scans.

5. Diagnostic Tests for OSA
1. Polysomnography (PSG): overnight PSG is considered the gold standard for diagnosing OSA.[6]
2. Home Sleep Testing (HST): HST is a portable diagnostic test that can be used to diagnose OSA in patients who are unable to undergo PSG.[7]
3. Oximetry: oximetry measures oxygen saturation levels in the blood and can be used to diagnose OSA.

6. Prosthodontic Diagnostic Criteria for OSA[8]
1. Apnea-Hypopnea Index (AHI): an AHI of 5 or higher is indicative of OSA. **(Table no.2)**
2. Oxygen Saturation: oxygen saturation levels below 90% are indicative of OSA.
3. Sleep Efficiency: sleep efficiency below 85% is indicative of OSA.
4. Sleep Fragmentation: sleep fragmentation, including frequent awakenings and arousals, is indicative of OSA.

AHI Severity Level	AHI Range (events per hr)	Description
Normal	Less than 5	Breathing events are within normal range, Indicating no clinically significant sleep apnea
Mild OSA	5-14	Mild sleep apnea is present. Though not severe, it is the gateway to understanding sleep health better.
Moderate OSA	15-29	Moderate sleep apnea has encroached: a nudge to action
Severe OSA	30 or more	Severe sleep apnea is at play, demanding urgent intervention

Table no.2 Apnea Hypopnea Index

IV. Management Of Obstructive Sleep Apnea

Behavioral Management	Medical Management	Surgical Management
• Weight loss • Avoidance of alcohol and sedatives • Avoidance of sleep deprivation • Nocturnal positioning	• Use nasal continuous airway pressure • Auto-continuous positive airway pressure • Bilevel positive airway pressure • Use oral appliances • Give medication • Treat associated diseases, e.g., hypothyroidism, acromegaly, allergic rhinitis	• Tracheostomy • Nasal procedure, e.g., turbinectomy, polypectomy, septoplasty • Uvulopalatopharyngoplasty • Laser assisted uvulopalatoplasty • Maxilla-mandibular advancement

V. Oral Appliances

Oral appliances for the treatment of airway obstruction were first addressed in 1923 in the literature by French pediatrician, Pierre Robin, who described the fall of the base of the tongue as the cause of nasopharyngeal impairment and proposed a prosthetic device to correct “the dysmorphic atresia of the mandible.” However, these appliances were not commonly used for the treatment of sleep disordered breathing until the early 1980s, when a tongue-retaining device for the treatment of snoring and sleep apnea was described by Cartwright and Samelson.

This device was followed by renewed interest in mandibular advancement devices (MADs) that reposition the mandible in a protrusive position in order to help maintain the patency of the upper airway during sleep.

The most commonly used oral appliance nowadays is the mandibular advancement appliance that holds the mandible in a forward direction minimizing the upper airway collapse during sleep.

Currently available appliances:

- First category: one piece appliance with no ability to advance the mandible incrementally.
- Second category: Appliance is principally two pieces in design and offers the potential for incremental advancement.
- Third category: They permit incremental advancement and lateral movement of mandible.

Mandibular advancement splints generate reciprocal forces on the teeth and jaw that can result in acute symptoms, as well as long-term dental and skeletal changes. While mandibular advancement splints are primarily attached to the dental arches, most extend beyond these arches and thus apply pressure to the gums and oral mucosa.

Mechanism of Oral Appliance Therapy Action

A mandibular advancement device functions by protruding and stabilizing the mandible in order to maintain a patent upper airway during sleep. The precise physiologic and anatomic changes that result from mandibular advancement remain elusive. Tsuiki and colleagues reported that the protruded mandible results in changes in the anteroposterior width of the upper airway, and positions of the hyoid bone and the third cervical vertebra. However, Ryan and colleagues reported that MAD use resulted in an increase in the lateral dimension of the velopharynx greater than the increase in the anteroposterior dimension.

Various clinical attributes have been associated with successful treatment outcome. These attributes include younger age, female sex, less severe obstructive sleep apnea (OSA), supine-dependent OSA, lower body mass index, and smaller neck Circumference. Analysis of lateral cephalometric images have shown an association between certain characteristics, such as retrognathic mandible, lower hyoid position, and greater angle between the cranial base and mandibular plane, with favorable MAD outcome. However, none of the cephalometric associations are considered strong enough to have any clinically significant predictive value. In short, there is currently no reliable way to predict who will respond positively to MAD based on observable clinical features.

Mandibular Advancement Device *(Figure no.3)*

Mechanism:

It protrudes the mandible forward, thus preventing or minimizing upper airway collapse during sleep.

Requirements:

• Good retention
• Sufficient protrusion to maintain airway
• Minimal vertical opening
• Full occlusal coverage

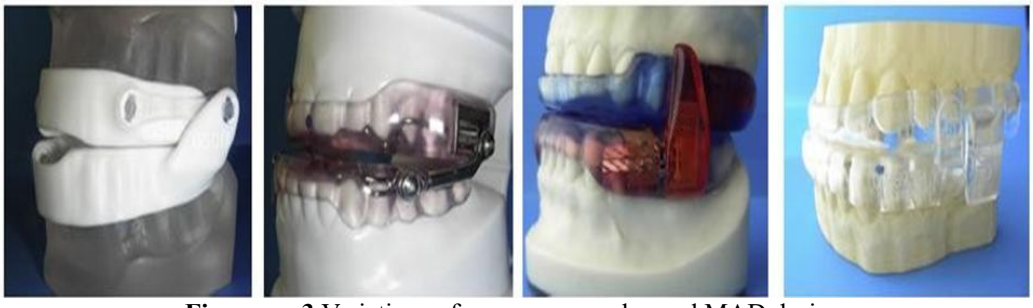

Figure no.3 Variations of some commonly used MAD designs

Tongue Retaining Device (TRD) *(Figure no.4)*

The TRD is an excellent device for edentulous patients or those who suffer from TMJ sensitivity. This is a one-piece device made of a nonrigid vinyl material without thermoplastic material to adapt to the teeth. Retention to the teeth or residual ridges is not a requirement with this device, and therefore rigidity of the device is unnecessary. The TRD functions by holding the tongue in a forward position by means of a suction bulb. When the tongue is in this position, the device keeps the tongue from collapsing during sleep and obstructing the airway in the throat.

Figure no.4 Tongue-retaining device (TRD).[9]

Indications
• Edentulous patients
• Patients with potential temporomandibular joint problems

Advantages of TRD:
• They do not require retention from dentition
• Minimal adjustments are required.
• Cause minimal sensitivity to teeth and TMJ.

Nocturnal Airway Patency Appliance (NAPA) *(Figure no.5)*

With this appliance, the mandible is in a protruded position during sleep. This serves to open the airway by indirectly pulling the tongue forward and keeping the soft palate attached to the tongue. This device has a hole in the front extended portion, to enable inhaling from the mouth.

Figure no.5 Nocturnal Airway Patency Appliance (NAPA)[10]

Mandibular Repositioner *(Figure no.6)*
This appliance has a hole in the front to enable inhaling from the mouth.

Mandibular repositioning appliances (MRAs) are intraoral devices designed to advance the mandible forward, thereby enlarging the upper airway and reducing pharyngeal collapse during sleep.

Mechanism of Action – By holding the mandible and tongue anteriorly, MRAs increase oropharyngeal airway space, decrease airway resistance, and improve airflow.

Indications – Recommended for patients with mild to moderate OSA, primary snorers, or in severe OSA when CPAP is not tolerated or contraindicated.

Types – Custom-made, titratable devices are most effective; non-custom (boil-and-bite) appliances exist but are less predictable.

Advantages & Limitations – Non-invasive, simple to use, and improve compliance compared to CPAP; however, may cause side effects like TMJ discomfort, occlusal changes, or excessive salivation.

Figure no.6 Mandibular Repositioner[10]

Klearway Oral Appliance *(Figure no.7)*

This custom-made two-piece appliance is composed of two separate arches (maxillary and mandibular) to advance the mandible with a screw (0.25 mm/1 turn) to determine the ideal forward position of the mandible required to adequately open the airway. A total of 44 forward positions are available in increments of 0.25 mm, which covers a full 11.0 mm range of anterior–posterior movement

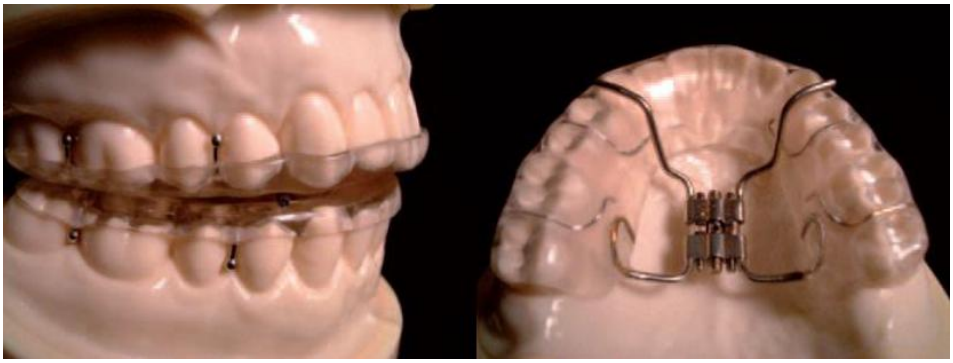

Figure no.7 Klearway Oral Appliance[10]

Thornton Adjustable Positioner (TAP) *(Figure no.8)*

This appliance is composed of two separate arches (maxillary and mandibular) containing an advancing mechanism and a base and hook assembly with an internal adjustment mechanism.

Figure no.8 Thornton Adjustable Positioner (TAP)[10]

Herbst Aplliance *(Figure no.9)*

This device contains an advancing mechanism which has two sets of pistons and tubes to keep the mandible in the forward position required to adequately open the airway.

Figure no.9 Herbst Aplliance[10]

The Elastic Mandibular Advancement Appliance (EMA) *(Figure no.10)*

It occupies less volume intra orally and is concise. It resembles orthodontic retainers made up of clear acrylic, and advances the mandible in sequential steps. It is indicated in macroglossia.

Figure no.10 The Elastic Mandibular Advancement Appliance (EMA)

Dorsal Appliance *(Figure no.11)*

Dorsal appliance is two-part design. The device provides the flexibility to patients to move their mandible antero-posteriorly, speak, or even yawn while engaging the mandible in a forward position.

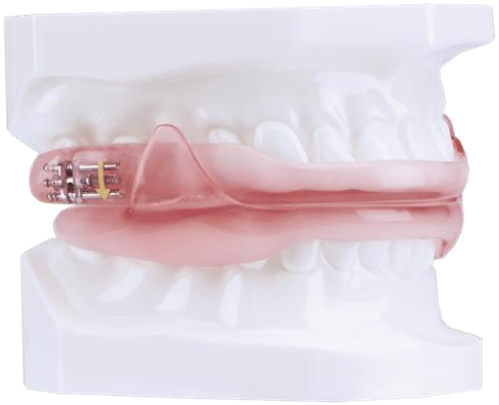

Figure no.11 Dorsal Appliance

Moses Appliance *(Figure no.12)*

Moses appliance is two-part design provides various advantages including decreasing of uncomfortable muscle activity, increasing tongue space availability, and reducing parafunctional habits. It allows for lip closure, freedom to speak, and enable drinking of water while wearing it.

Figure no.12 Moses Appliance

Prosomnus® Sleep And Snore Device *(Figure no.13)*

It is a CAD/CAM technology fabricated custom made antisnoring appliance. Their two-part structure allows enough space within the mouth so that the tongue can rest comfortably while one is asleep.

Figure no.13 Prosomnus® Sleep And Snore Device

Palatal Lift Prosthesis *(Figure no.14)*

Palatal Lift Prosthesis markedly increased the upper airway passage dimension there by eliminating snoring and ensuring patency of airway is maintained during sleep.

Figure no.14 Palatal Lift Prosthesis[11]

Provent *(Figure no.15)*

Provent works by incorporating principle of 1-way valve which generates consistent pressure in posterior region of pharynx. The main attribute of this device is its easy maneuver. This device is worn over the nostrils like a tape. This appliance has been available in the European market for management of OSA.

Figure no.15 Provent

Oral appliances may be used alone or in combination with other means of treating OSA, including weight control, surgery, or CPAP. Recently, oral appliance therapy was performed along with CPAP therapy to reduce the pressure flow of the CPAP machine. However, there will be a growing number of combination treatments developed in the near future.

VI. Future Perspectives

The future of managing obstructive sleep apnea (OSA) within prosthodontics is poised for significant transformation, driven by recent advances and emerging technologies. Key developments include:

Digital Dentistry: Digital dentistry is transforming the management of obstructive sleep apnea (OSA) by integrating advanced technologies that enhance both diagnosis and treatment efficacy. One of the key innovations is the use of cone beam computed tomography (CBCT), which provides detailed three-dimensional imaging of the airway and surrounding structures. This precise visualization helps dental professionals assess the severity of OSA and tailor treatment plans accordingly.

In addition, computer-aided design and manufacturing (CAD/CAM) systems allow for the creation of custom oral appliances that fit patients more comfortably and effectively. Digital workflows also streamline the entire process, from initial consultation to final appliance delivery, significantly reducing turnaround times.

Smart Appliances: Smart appliances are revolutionizing the management of obstructive sleep apnea (OSA) by integrating advanced technology with traditional treatment methods. These devices, often custom-made for individual patients, utilize sensors and connectivity features to monitor sleep patterns, jaw position, and breathing rates in real-time.[12]

AI and Machine Learning: Artificial Intelligence (AI) and machine learning are increasingly being integrated into the management of obstructive sleep apnea (OSA), offering innovative solutions for diagnosis, treatment, and ongoing monitoring. These technologies enhance traditional approaches and promise to improve patient outcomes significantly.[13]

Interdisciplinary Collaboration: Obstructive Sleep Apnea (OSA) is a complex condition that often requires a multidisciplinary approach for effective management.[14] This involves collaboration among various healthcare professionals, including dentists, sleep specialists, primary care physicians, and respiratory therapists. Such collaboration is crucial for comprehensive diagnosis, treatment planning, and ongoing patient care.

- Comprehensive Diagnosis: Collaboration allows for a thorough evaluation of patients. Dentists may identify signs of OSA during routine examinations, while sleep specialists perform polysomnography to confirm the diagnosis. This combined effort enhances diagnostic accuracy and ensures all aspects of the patient's health are considered.

- Customized Treatment Plans: Interdisciplinary teams can create tailored treatment plans that incorporate oral appliances, Continuous Positive Airway Pressure (CPAP) therapy, lifestyle changes, and surgical options. This ensures that each patient's unique needs are met, improving adherence and outcomes.
- Ongoing Management: Regular follow-ups involving multiple disciplines can help monitor treatment effectiveness, adjust strategies, and address any emerging issues. This holistic approach is essential for long-term success.

VII. Conclusion

Prosthodontic management plays a pivotal role in the multidisciplinary treatment of obstructive sleep apnea, offering non-invasive and patient-centered solutions, especially for those intolerant to CPAP therapy. Oral appliance therapy, particularly mandibular advancement devices and tongue-retaining appliances, has demonstrated significant efficacy in reducing apnea-hypopnea indices and improving sleep quality. As prosthodontists, a comprehensive understanding of airway dynamics, occlusion, and appliance design is essential to ensure optimal therapeutic outcomes. Continued collaboration with sleep physicians, advancements in digital technologies, and individualized treatment planning will further enhance the efficacy and acceptance of oral appliance therapy. Future research and long-term clinical studies are warranted to refine prosthodontic protocols and validate their role as a standard of care in OSA management.

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