REVIEW ARTICLE

Sleep Apnea: More than Just a Noise

S Meenakshi, N Raghunath

ABSTRACT

Obstructive sleep apnea is a sleep disorder of airflow at the nose and mouth during sleep. Patients with undiagnosed sleep apnea represent a major public health problem. Dental professionals have a unique doctor patient relationship that can help them in recognizing the sleep disorder and managing the patients along with a physician or a sleep specialist. Oral appliance therapy is an important treatment modality for sleep apnea patients.

This article discusses the etiology, clinical features, diagnosis and various treatment options with special reference to oral appliances used for obstructive sleep apnea.

Keywords: Snoring, Obstructive sleep apnea (OSA), Oral appliance therapy, AHI.

How to cite this article: Meenakshi S, Raghunath N. Sleep Apnea: More than Just a Noise. J Orofac Res 2012;2(2): 76-81.

Source of support: Nil

Conflict of interest: None declared

INTRODUCTION

Sleep apnea is a potentially life-threatening sleep disorder characterized by repeated pauses in breathing during sleep. The term sleep apnea is derived from the Greek etymology meaning 'without breath'. Breathing pauses can last anywhere from several seconds to minutes, and happen as often as 30 times or more per hour. Ongoing disrupted breathing causes an imbalance between the carbon dioxide and oxygen levels in the bloodstream, as not enough carbon dioxide is exiting and not enough oxygen is entering the body.

There are two main types of this disorder; central sleep apnea which occurs when the brain fails to send important signals to the breathing muscles, and obstructive sleep apnea which occurs when air cannot flow through the nose or mouth even though the body is still trying to breathe. Obstructive sleep apnea is far more prevalent and easily treatable by the dentist (Figs 1 and 2).

This disorder causes significant morbidity, particularly in terms of daytime functioning and its impact on quality of life. It is well documented by various studies that sleep disordered breathing and obstructive sleep apnea (OSA) have many health-related consequences which include hypertension, myocardial infarction, stroke, diabetes, depression, excessive daytime fatigue and greater risk of automobile accidents.[1,2]

Untreated OSA is associated with poor work performance and reduced quality of life and may affect the patient on personal, social and professional levels.[3]

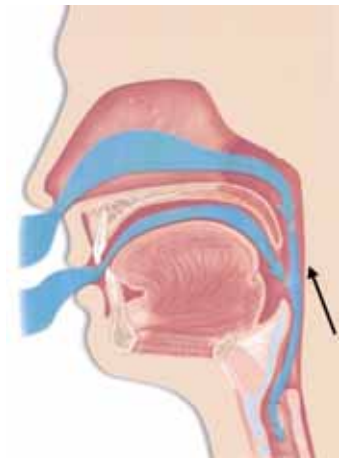

Fig. 1: Upper airway space of patient with normal anatomy, with unrestricted passage of air through upper airway (*Courtesy*: Ivanhoe JR, Treatment of upper airway sleep disorder patients with dental devices, Quintessence 2000:215-31)

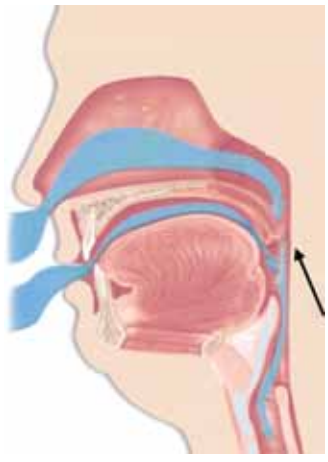

Fig. 2: Upper airway space of snoring patient demonstrates partial closure of airway space between tongue and posterior wall of pharynx and simulated vibration of uvula (*Courtesy*: Ivanhoe JR, Treatment of upper airway sleep disorder patients with dental devices, Quintessence 2000:215-31)

The dental professionals have a unique opportunity to play a role in management of sleep breathing disorders and improve the quality of life for patient seen in dental practice.

Etiology and Pathogenesis

Obstructive sleep apnea occurs in 2 to 4% of adult population between the ages 30 and 60 years though evidence suggests that many more patients remain undiagnosed. OSA is characterized by a collapsing of the tongue back out the pharynx during sleep. Typically, this is because of large tongue, small air pathway or abnormal throat anatomy. This blockage restricts breathing, lowering the concentration of

oxygen in the blood until receptors in carotid sinus are altered to higher CO_2 levels in the body causing the patient to wake up and normal breathing is restored. When patient falls into deep sleep, tongue collapses again and another apneic episode takes place. The number of unintentional pauses in breathing, in a given night can be as high as 100 or more per hour. It is frequently accompanied by snoring but not everyone with sleep apnea snores. Alcohol is frequently a cofactor because of its depressant influence on upper airway muscles and on arousal response that terminates each apnea.[5]

In most patients patency of the airway is compromised structurally and therefore predisposed to malocclusion. In minority of the patients, structural compromise is due to obvious anatomic disturbances, such as adenotonsillar hypertrophy, retrognathia and macroglossia. However, in majority of patients' structural defect is simply a subtle reduction in airway size that can be appreciated as pharyngeal crowding and can be demonstrated by imaging techniques. Obesity frequently contributes to decrease in size of upper airway by increasing fat deposition or compressing the pharynx by superficial fat mass in the tongue[5] (Fig 3).

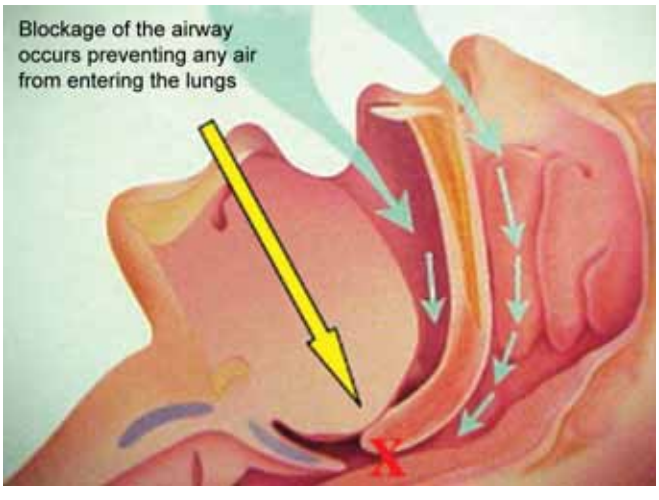

Fig. 3: Blockage of airway (*Courtesy*: Ivanhoe JR, Treatment of upper airway sleep disorder patients with dental devices, Quintessence 2000:215-31)

Prevalence

According to the latest statistics of World Health Organization (WHO), globally, there were more than 1.6 billion overweight adults and at least 400 million obese in 2005 on earth. WHO further projects that by 2015, approximately 2.3 billion adults will be overweight and more than 700 million will be obese.[4] Amazingly, over 20 million children under age of 5 years were overweight in 2005.[1] Obese and overweight individuals have much higher chance of snoring or having obstructive sleep apnea.

CLINICAL FEATURES

The signs and symptoms of OSA include snoring, excessive daytime sleepiness, gasping or choking during the night, nonrefreshed sleep, fragmented sleep, clouded memory, irritability, personality changes, decreased sex drive, impotence and morning headaches. Sleep apnea is a chronic health problem and is also a progressive condition which means it can potentially worsen overtime.

Predisposing Factors

One of the most important predisposing factors is obesity. Over two-thirds of the patients with obstructive sleep apnea are >20% above their ideal body weight. Generally, obesity is also associated with larger neck size. If an individual's neck circumference is greater than 42.5 cm, with double chin, the chance of apnea increases significantly.[10] This in part is related to the anatomical changes that happen with increased body mass. First, the tongue is pushed up, hence reducing the size of the oral airway. More importantly, if patient sleeps on his/her back the airway is obstructed from the base of tongue pressing against it.[11-14] Also radiographic and magnetic resonance imaging (MRI) studies of overweight and obese patients show a reduction in size of the hypopharyngeal airway. But airway blockage could be at many levels including the obstructive tonsils and adenoids, nasal obstruction from a deviated septum or enlarged nasal turbinate, and other upper airway structures constricting the airway. Craniofacial as well as maxillofacial anomalies can play an important role in obstructive sleep apnea cases. In particular, patients with bimaxillary or mandibular retrognathism with a receded chin are more prone to develop signs of obstructive sleep apnea (Fig. 4). This brings an important issue to our professions attention when treating patients with severe mandibular prognathism to avoid impinging the airway by merely moving the mandible backward, hence obstructing the airway.

Fig. 4: Tissues that can affect snoring (*Courtesy*: Ivanhoe JR, Treatment of upper airway sleep disorder patients with dental devices, Quintessence 2000:215-31)

Studies done by Japanese scientists indicate that as tongue volume increases with BMI, the posterior airway is affected, and thus is likely to be involved in the development of OSA.

Examination

1. This should include blood pressure monitoring
2. Neck circumference measurement (>17" in males and >15.5" in females is significant),
3. Upper airway examination to evaluate:
   a. Low hanging bulky soft palate, large tonsils, large tongue
   b. Low hyoid position or maxillomandibular deficiency
   c. Dental malocclusion
   d. Wear facets (as bruxism is frequently associated with OSA).

DIAGNOSIS

Medical Diagnostics

- Polysomnography is the gold standard for diagnosing OSA and consists of detailed overnight sleep study in a laboratory.[6] Apnea is defined as cessation of airflow, a complete obstruction for 10 seconds with a consistent 2 to 4% drop in arterial oxygen saturation. Hypopnea is reduction in airflow for at least 30 to 50 and with a drop in oxygen saturation. The apnea hypopnea index (AHI) is average number of apneas and hypopneas per hour of sleep. OSA severity is classified on basis of patients AHI score into mild (AHI score between 5-15), moderate 1(AHI score between 15-30) and severe (AHI score greater than 30).[7] Not all studies adhere to numerical parameters of this classification. Other factors that also influence the severity of OSA include desaturation, quality of life and level of daytime sleepiness.
- The multiple sleep latency test (MSLT) is used to establish how rapidly the patients falls asleep to distinguish it from narcolepsy.
- The Epworth sleepiness scale is a questionnaire used to screen for sleep apnea.[8]
- The mallampati score (grade 1-4). There are 4 'grades', and the higher the grade, the smaller the air passage, which is another indicator of sleep disordered breathing, can be used as a predictor of sleep apnea particularly in cases where an enlarged tongue seems to be the cause for airway obstruction[9] (Fig. 5).
- Lateral cephalometric radiographs reveal the diversion of airway column, position of hyoid bone and craniofacial skeleton for any maxillomandibular deficiencies.
- Fibro-optic nasopharygoscopy to examine three-dimensional structure of the airway revealing any anatomic site of obstruction.

Fig. 5: Mallampati score

Dental Diagnostics

A dentist may be the first health care provider to identify an individual with sleep disorder because its salient signs and symptoms are often recognizable in the dental practice.

Common clinical findings include:

1. Excess fat deposition in the palate and tongue (possibly causing a true macroglossia) and pharynx – narrowing the airway.
2. Individuals with small (micrognathia) and retrognathic jaws.
3. Macroglossia with reduced functional space and is forced posteriorly toward the pharyngeal wall and superiorly above the plane of occlusion.
4. Soft palate is elongated and enlarged and positioned posteriorly, uvula will not be seen during phonation because it lies below the base of the posteriorly positioned tongue.

A study was conducted to investigate the influence of the size ratio of tongue and mandible (T/M ratio) on the upper airway with 3D reconstructed models from computed tomography (CT) data and concluded that as tongue volume increases with BMI (body mass index), the posterior airway is affected, and thus is likely to be involved in the development of OSA.[25]

MANAGEMENT OF PATIENT WITH OSA

Life Style Modification

- This includes positional therapy, i.e. placing the patient in nonsupine position to prevent patients from sleeping in a supine position. In mild cases nonsupine position may relieve the obstruction. However, most patients with

sleep disordered breathing (SDB) show apnea in all position thus, this technique is only useful for simple snoring.

- Alcohol consumption should be avoided in the evening as alcohol may relax the airway making the airway more prone to obstruction at susceptible sites.
- Weight loss is recommended for all overweight patients to control sleep apnea. Continuous positive airway pressure (CPAP): Sullivan et al reported the use of nasal continuous positive airway pressure (CPAP) for treatment of OSA.[10] Nasal CPAP maintains the upper airway patency during sleep by way of a pneumatic stent. The treatment is administered via nasal or oral mask. It is most prescribed treatment for OSA for moderate-to-severe cases[11] and is almost always effective, but its success is limited by patient's level of compliance is poor which is estimated to be 30 to 40%. The CPAP machine is large and cumbersome and its use can have irritating side effects, such as nasal congestion and throat dryness. Although CPAP is the treatment of choice in patients with moderate-to-severe OSA, it has poor patient compliance because of problems with portability, cost, pump noise, dryness of the airway passage, claustrophobia and nasal leaks with mask discomfort.

Oral Appliance Therapy in Management of OSA

Oral appliances find their greatest success when utilized for simple snoring, upper airway resistance syndrome and mild-to-moderate obstructive sleep apnea. Improvement of snoring occurs in high proportion of patient with complete resolution in smaller subset. A large literature review by Lowe showed that, as group's oral appliances were effective in mild-to-moderate OSA with 75% compliance rate.[12] Oral appliance therapy has been accepted by the American Sleep Disorder Association as an appropriate treatment modality for OSA patient. Oral appliances can lift the soft palate or advance tongue or mandible thus opening the airway. A combination of oral appliances and CPAP is also used in a few cases.

Soft Palate Lift Appliances

Those that lift the soft palate are rarely used because of gag, discomfort and success of laser and radiofrequency soft palate procedures.

Tongue retention: Tongue retaining devices (TRD) have an anterior hollow bulb, which creates a negative pressure vacuum when tongue is inserted. Tongue is held forward away from postpharyngeal wall, opening the airway. This appliance simultaneously modifies the position of the mandible (Fig. 6).

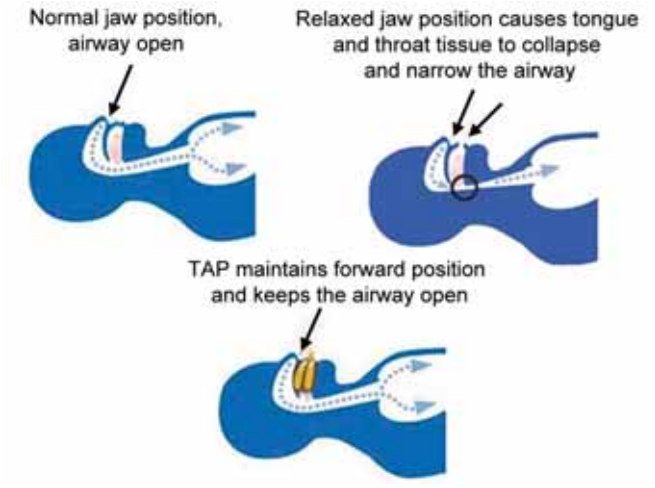

Fig. 6: Oral appliance in position (*Courtesy*: Ivanhoe JR, Treatment of upper airway sleep disorder patients with dental devices, Quintessence 2000:215-31)

Mandibular repositioning or advancement devices (MRD/MAD) function by engaging one or both of dental arches to modify mandibular protrusion and improve the velopharyngeal airway patency.[13] The most common mandibular repositioning dimension quoted is 50 to 75% of maximal protrusion (Approximately 5-7 mm).[14] As these appliances hold the mandible in anteroinferior position, these indirectly bring the tongue forward as a consequence of muscle attachment and open up the posterior airway. The repositioning may also stretch and reduce the collapsibility of soft palate via its connection to the base of tongue and increase the superior airway space.

Although tongue repositioning devices and mandibular advancement devices have been standard appliances for treatment of OSA, a recent study be Venket R et al describes the use, four new prosthodontic appliances for managing sleep apnea namely uvula lift appliance, uvula and velopharynx lift appliances, nasopharyngeal aperture guard and soft palate lift appliance and a conventional mandibular advancement appliance. He concluded that nasopharyngeal aperture guard appliances was the best among the five types of appliances.[14] Further studies would be required in this direction.

Edentulous patients tend to be higher than that of the general population. Loss or absence of teeth produces prominent anatomical changes that may influence upper airway size and function, such as loss of the vertical dimension of occlusion resulting into reduction of height of the lower face and mandibular rotation. Rehabilitation of edentulous patients with complete dentures is an integral part of prosthodontic treatment. A denture not only provides esthetics and improves the phonetics but also restores the desired function of mastication and also provides adequate support to orofacial structures by restoring altered vertical dimension of face. Besides, it also improves OSA/hypopnea.[24]

Design Consideration of OA

Till date, more than 40 different OAs have been patented. Design variations depend upon:

- Method of retention
- Flexibility of material
- Adjustability
- Vertical opening
- Freedom of jaw movement.

According to the material used these can be either polyvinyl vacuum formed thermoplastic appliances or those made of hard acrylic. According to adjustability these may be fixed or adjustable. Fixed oral appliances are usually one piece design that can be adjusted in the anteroposterior plane.[26]

One of the accepted designs is one piece nonadjustable soft vinyl vacuum formed mandibular repositioning appliance consisting of thermoplastic material covering the maxillary and mandibular arches in the desired anterosuperior position. The occlusal position is established and recorded by either a wax bite, silicon bite or anterior jig with inter occlusal registration.[15]

In the two part Herbst—style appliance, the arches are connected by pivoting bars that can be altered in length to titrate the protrusive mandibular position for effectiveness and comfort. The occlusal registration for these two part appliances is not as important because mandibular reposition can be titrated from the intercuspal position.[15]

TAP (Thornton adjustable positioner) appliance uses a hook on the maxilla to attach to the mandible in order to bring it forward.

For edentulous patients with OSA, a tongue stabilizing device (TSD) can be used which does not attach to teeth and acts as a pacifier. It is made of soft silicon and holds the tongue forward by gentle suction preventing it from falling back. Implant retained mandibular repositioning device in the mandible is a viable treatment modality for edentulous OSA patients[16] (Fig. 7).

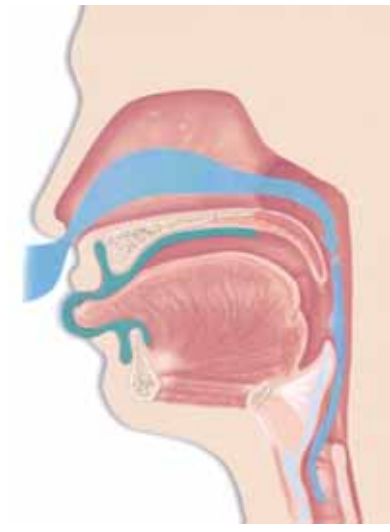

Fig. 7: Tongue retaining device on edentulous ridge, tongue is held in anterior position by suction created in hollow bulb (*Courtesy*: Ivanhoe JR, Treatment of upper airway sleep disorder patients with dental devices, Quintessence 2000:215-31)

Advantages of Oral Appliances

The advantages of oral appliances over other sleep apnea treatment options include relatively low cost, good success rates (efficacy comparable to uvulopalatopharyngoplasty but less efficacious than CPAP), good compliances a more benign adverse-effect profile, rapid effect and easy termination without sequalae.[17] OA (oral appliances) insertion can be performed as a single stage procedure is an outpatient setting. These can be used effectively for simple snoring and mild-to-moderate OSA as recommended by American Academy of Sleep Medicine,[18] but a study by Jeffery Pancer concluded that oral appliances appear to be effective treatment alternative for selected patients of snoring and varying degrees of sleep apnea including those with severe OSA.[19]

OAs improve the blood oxygen saturation levels as they relieve the apnea in 20 to 75% of patients. They reduce the AHI (apnea hypopnea index—is average number of apneas and hypopneas per hour of sleep) to <10 events per hour or bring about 50% reductions in AHI. They also reduce AHI to normal in 50 to 60% of the patients.

A recent study, by Kazvya Yoshida[20] reported that appliance therapy in selected population resulted in a significant fall of about 3.7 mm Hg in mean arterial pressure. The blood pressure response was significantly associated with AHI reduction thus proving efficacy of oral appliance therapy. The reduction in blood pressure in turn would reduce the risk of coronary heart disease and stroke. Side effects with oral appliances are generally minor and include excessive salivation, muscle and tooth discomfort and occasionally temporomandibular joint discomfort. But symptoms usually improve overtime.[21]

SURGERY AS TREATMENT OPTION

Surgery should be considered as last treatment of option of OSA. A widely accepted procedure to treat snoring and sleep apnea is uvulopalatopharyngoplasty (UPPP)[21] which has a success in less than half of all cases. Repositioning of hyoid bone is another treatment modality. Maxillo mandibular advancement (MMA) surgery is another effective surgical procedure. Nasal surgery, such as turbinectomy and septoplasty may reduce AHI but normally nasal surgery is used in combination with other surgical procedures. Pillar palatal implant system is a newer treatment option.[22] This

system involves the placement of three mesh polyethylene tetraphthalate implants within the soft palate muscles under local anesthesia. These permanent implants improve snoring by stiffening the palate and decreasing its vibratory movement during inspiration.[23]

DISCUSSION AND CONCULSION

The recognition and treatment of snoring and obstructive sleep apnea are two medical areas where dentistry can play a valuable role. Due to relative lack of public and professional attention given to sleep apnea, it is important that when indicated the patients be asked about snoring, daytime sleepiness and other signs and symptoms of OSA. Oral appliance therapy has been accepted as an appropriate treatment modality for some patients by American Sleep Disorders Association. However, it is necessary that a dentist works as a part of the treatment team which includes a physician and a sleep specialist and not assumes responsibility for diagnosis and treatment himself. Considering that obstructive sleep apnea greatly increases patients chances of heart attack, stroke and early death, dentist might be in a critical position to screen patients, refer patients and treat patients and assume a primary role in saving lives.

REFERENCES

1. Waller PC, Bhopal RS. Is snoring a cause of vascular disease: An epidemiological review. Lancet 1989;1:143-46.
2. Shamsuzzan AS, Gesh BJ, Somers VK. Obstructive sleep apnea: Implications for cardiac and vascular diseases. JAMA 2003;1906-14.
3. Kelly R Magliocca, Joseph I Helman. Obstructive sleep apnea. Diagnosis, medical management and dental implications. J Am Dent Assoc 136(8):1121-29.
4. Young T, Palta M, Demsey J, Skatrud J, Weber S, Badt S. The occurrence of sleep disordered breathing among middle aged adults. N Engl J Med 1993;328:1230-35.
5. Eliot A Phillipson. Sleep apnea Harrison's priciples of internal medicine (16th ed), McGraw Hill Medical Publishing Division 2005;2:1573-76.
6. Polysomnography Task Force, American Sleep Disorders Association Standards of Practice Committee. Practice parameters for the indications for polysomnography and related procedure. Sleep 1997;20:406-22.
7. Flemons WW, Buysse D, Redline S, et al. Sleep related disorders in adults: Recommendations for syndrome definition and measurement techniques in clinical research – the report of an American Academy of Sleep Medicine Task Force. Sleep 1997; 22:667-89.
8. Johns MW. A new method measuring daytime sleepiness: The Epworth sleepiness scale. Sleep 2001;14:540-45.
9. Freidman M, Tanyeri H, LaRosa M, Landsberg R, Vaidyanathan K, Pieri S, et al. Clinical predictors of obstructive sleep apnea. Laryngoscope 1999;109:1901-07.
10. Sullivan CE, Issa FG, Berthon Jones M, Eves L. Reversal of obstructive sleep apnea by continuous positive airway pressure applied through the nares. Lancet 1981;1:862-65.
11. Joo MJ, Hendegen JJ. Sleep apnea in an urban public hospital: Assessment of severity and treatment adherence. J Clin Sleep Med 2007;3:285-88.
12. Lowe AA. Dental appliances for treatment of snoring and sleep apnea. In: Kruyger M, Roth T, Dement W (Eds). Principles and practice of sleep medicine (2nd ed). Philidelphia: WB Saunders Co 1994;722-35.
13. Isono S, Tanaka A, Sho Y, Konn A, Nishino T. Advancement of mandible improves velopharygeal airway patency. J Appl Physiol 1995;79:2132-38.
14. Venkat R, Gopichander N, Vasantkumar M. Four novel prosthodontics method for managing upper airway resitance syndrome: An investigative analysis revealing the efficacy of the new nasopharyngeal aperture guard appliance, Indina J Dent Res 2010;21:44-48.
15. D Saee S, S Sarin P, Pravin S. Obstructive sleep apnoea: Dental implications and treatment strategies. The Internet Journal of Dental Sciences 2009;7:1.
16. Aarnoud Heokema, Frist de Vries, Kees Heydenrijk, Boudewijn Stegenga. Implant-retained oral appliances: A novel treatment for edentulous patients with obstructive sleep apnea—hyponea syndrome. Clinical Oral Implants Research 2007;10(3):383-87.
17. Padma A, Ramakrishnan N, Narayan V. Management of obstructive sleep apnea: A dental perspective. Indian J Dent Res 2007;18:201-09.
18. Practice parameters for the treatment of snoring and obstructive sleep apnea with oral appliances. American Sleep Disorders Association 1995;18:511-13.
19. Jefferey Pancer, Salem Al Faidi, Mohamed Al Fiadi, Victor Hoffstein: Evaluvation of variable mandibular advancement appliances for treatment of snoring and sleep apnea. Chest 1999;116:1511-18.
20. Kazya Yoshida. Effect on blood pressure of oral appliance therapy for sleep apnea syndrome. Int J Prosthodont 2006;19:61-66.
21. Kathleen A, Ferguson MD, Rosalind Cartwright, Robert Rogers, Wolfgang Schmidt Nowara. Oral appliances for snoring and sleep apnea: A review Sleep 2006;29(2):244-62.
22. Marshall MW. Surgical options for obstructive sleep apnea: J Calif Dent Assoc 1998;26:579-90.
23. Michael Friedman, Paul Schalch. Palatal stiffening after failed uvulopalatopharyngoplasty with the Pillar implant system. Operative techniques in Otalaryngology Head and Neck Surgery. 2007;18(1):7-10.
24. Gupta Prachi, Thombare Ram, Singhal Sameer, Pakhan AJ. Indian Journal of Sleep Medicine 2010;5(4).
25. Yuko Shigeta, Takumin Ogawa. Oral surgery, Oral medicine Oral pathology. Oral Radiology 2011 Feb;111(2):239-43.
26. John R Ivanhoe, Roman M Cibirka, Carol A Lefebvre, Gregory R. Dental considerations in upper airway sleep disorders: A review of the literature. J Prosthet Dent 1999;82:685-98.

ABOUT THE AUTHORS

S Meenakshi (Corresponding Author)

Senior Lecturer, Department of Prosthodontics, JSS Dental College and Hospital, Mysore, Karnataka, India, Phone: +919886494066 e-mail: itsprosthodontist@gmail.com

N Raghunath

Professor, Department of Orthodontics and Dentofacial Orthopedics JSS Dental College and Hospital, Mysore, Karnataka, India