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Obstructive sleep apnea (OSA): A prosthodontic perspective

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ABSTRACT

The subject of sleep medicine, for dental profession in general and prosthodontists in particular, continue to offer great challenges and opportunities in terms of diagnosis, treatment planning and treatment based on qualitative evidence. Although the role played by the prosthodontists is still in its infancy, there is much to learn and understand in the rapidly evolving field of sleep medicine as the recognition of co-managing patients with sleep disorders by the prosthodontists is fast becoming a reality. This article discusses at length the prosthodontic perspectives of the research in the field of sleep medicine, particularly on obstructive sleep apnea.

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Introduction

Sleep disordered breathing (SDB) is an extremely common medical disorder associated with important morbidities. Obstructive sleep apnea (OSA) is one such chronic condition of upper airway collapse during sleep characterized by repetitive episodes of cessation of respiration (apnea) or decrements in airflow (hypopnea), associated with sleep fragmentation, arousals and reductions in oxygen saturation.

Loss of teeth or edentulism plays a very important role in terms of respiratory process, body balance and in turn overall health of the stomatognathic system. The subject of sleep medicine, for dental profession in general and prosthodontists in particular, continue to offer great challenges and

opportunities in terms of diagnosis, treatment planning and treatment based on qualitative evidence. The recognition of co-managing patients with sleep disordered breathing, by the prosthodontists is well justified ever since interest began in the research associated loss of teeth and severity of sleep apnea during 1990s^{1–3} and have been immensely influenced by the concomitant research data emerging in the field of sleep medicine.

The limited published data from the 1990's onwards, has addressed the technique for fabrication of oral appliances in sleep apnea patients.³ The quality of evidence which has emerged linking the loss of teeth with increased incidence of OSA and the role of nocturnal wear of complete dentures in decreasing the severity of OSA has generated tremendous

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interest and contest.^{1,3–5} Till date, the exact mechanism underlying the relation between edentulism and OSA remains to be clearly understood.

From a prosthodontic standpoint, reports on individualized oral appliance therapy for edentulous and partially edentulous sleep apnea patients continue to be published; however, consensus is yet to emerge on many aspects of management. Some of the unresolved issues include the effect of concomitant bite opening with mandibular advancement on efficacy of oral appliance therapy, the role of complete denture wear during sleep, the impact of increased vertical dimension during complete denture wear during sleep, and implant retained mandibular repositioner appliance for edentulous sleep apnea patients. Criticism has been expressed on the utilization of 2-D cephalometric imaging modalities in assessing 3-D upper airway dimensions in upright and awake condition to predict changes occurring during sleep.^{6,7}

Role of edentulism in pathogenesis of OSA

While edentulism has been linked to a wide range of health outcomes, its possible association with OSA has assumed greater significance due to the immense prosthodontic implications on sleep medicine. The links between poor health conditions and edentulism are obvious, yet evidence on a causal relationship via physiological mechanisms is limited, hence common risk factors are widely discussed. This is true in case of tooth loss; edentulism & its association with sleep disordered breathing such as OSA.⁸

Edentulism has been shown to produce anatomical changes in craniofacial structures, and hypothesized to increase obstructive sleep apnea (OSA). However, the relationship between patients with and without teeth and severity of OSA has not been well-studied. The following anatomical changes ensue due to loss of teeth (Figs. 1–3):

- Decrease in vertical dimension of occlusion
- Change in position of mandible
- Change in position of hyoid bone

Fig. 1 – Elongated uvula.

Fig. 2 – Enlarged tongue.

- Impaired function of oropharyngeal musculature such as loss of tone in soft palate and pharynx, macroglossia etc.

Effects of complete denture wear with and without increased vertical dimension on OSA

In several ways, receiving prosthodontic treatment for tooth loss signifies a return to normal lifestyle and improved quality of life. Given the common occurrence of both loss of teeth and sleep disordered breathing conditions, the relationship between these two conditions has indeed warranted a detailed investigation of the mechanisms whereby loss of teeth leads to upper airway closure during sleep.

Bucca et al (1999) had confirmed that removal of denture significantly decreases the retropharyngeal space, and sleeping without dentures significantly increases AHI, and decreases arterial hemoglobin saturation.¹ Pivetti et al (1999), reported that edentulism may dramatically worsen severity of obstructive sleep apnea (OSA) and advised edentulous patients to wear dentures while sleeping.² Carossa et al (2000) concluded that edentulous subjects had a significantly higher prevalence of arterial hypertension and cardiovascular diseases, compared to subjects with natural teeth. Thus, in edentulous subjects, removing dentures during sleep may favor respiratory disorders, and increase the risk for hypertension and cardiovascular disease.⁹

Endeshaw et al (2004) found an association between sleep disordered breathing and denture use, which may represent a

Fig. 3 – Loss of vertical dimension in an edentulous patient.

relationship between sleep disordered breathing and edentulism.⁸ Erovigni et al (2005) demonstrated that wearing denture induces modifications in the position of the tongue, mandible and pharyngeal airway space which can favor the reduction of apnea episodes.⁶ Bucca et al (2006) concluded that edentulism might worsen obstructive sleep apnea, particularly in subjects with no respiratory disturbances sleeping with dentures. Edentulism might act by modifying anatomy and function of the pharyngeal airway and tongue and favoring inflammatory edema. They suggested that the advantage of removing dentures during sleep should be weighed against the risk of favoring upper airway collapse.⁴ Arisaka et al (2009) concluded that wearing complete dentures during sleep improves the AHI of most edentulous OSA patients.¹⁰ Tsuda et al (2010) found the prevalence of suspected SDB in edentulous subjects was higher than in the general population.¹¹

Gupta et al (2010), demonstrated through lateral cephalometry that significant changes were observed in retropharyngeal space with wearing of complete dentures fabricated with acceptable vertical dimension of occlusion in comparison to edentulous subjects without dentures. These changes were more significant in same subjects after increasing vertical dimension of occlusion by 2 mm using custom made acrylic jig in comparison to edentulous subjects.³

Morelli et al (2011), collected magnetic resonance imaging (MRI) and polysomnography on 585 patients and concluded that edentulous apneics had a wider and shorter tongue than apneics with teeth.¹²

The disadvantages of wearing dentures during sleep are due to the fact that they are associated with chronic inflammatory changes, leading to irritation and alveolar bone resorption in the denture-supporting area. In addition, increasing the vertical dimension of occlusion can cause strain on temporomandibular joint and the patient may need more time for adaptation to the same.

Review of oral appliance therapy in complete and partially edentulous OSA patients

Continuous positive airway pressure (CPAP), surgery and oral appliance therapy remain at the forefront of definitive treatment modalities for patients with OSA. Oral appliance therapy has emerged as a conservative, noninvasive treatment option for patients with OSA.¹³ Oral appliance therapy mainly dwells on mandibular advancement with or without increasing the vertical dimension and retaining tongue from falling back. It is interesting to note that throughout the literature the words 'oral appliance', 'prosthesis', 'splint' and, 'device' have been used interchangeably. Confusion also exists in usage of words between 'mandibular advancing' & 'mandibular repositioning'; and between the words 'tongue retaining', 'tongue stabilizing', 'tongue repositioning' & 'tongue advancing'. Readers are advised to use their discretion as consensus is lacking on appropriate usage of terms.

Partial and complete edentulism have long been considered as a contra-indication for oral appliance therapy as retention becomes questionable. However, many

modifications for denture design concepts have been incorporated while fabricating in these situations to ensure patient compliance and clinical efficacy.

Mucosa supported oral appliances for completely edentulous patients

Meyer & Knudson (1990) were the first to report a clinical and laboratory technique for fabrication of a prosthesis which prevented sleep apnea in edentulous patient. Their technique involved positioning the edentulous mandible 5–8 mm open and anterior to physiologic rest position using a heat-cured acrylic monobloc prosthesis. They concluded that the prosthesis would be effective only if the suspected site of the obstruction is at the level of the base of the tongue and the posterior pharyngeal wall.¹⁴ Robertson (1998), described "combination appliance" wherein increase in vertical dimension and forward protrusion of mandible prevented obstructive sleep apnea in an edentulous patient.¹⁵ Nayar & Knox (2005), highlighted the paucity of literature on the treatment of OSA in edentulous patients with a mandibular advancement splint and described a clinical and laboratory method for an acrylic monobloc splint without an increase in vertical dimension of occlusion in edentulous OSA patient. They theorized that increasing the occlusal vertical dimension would decrease the space between the base of the tongue and the posterior pharyngeal wall thus negating the benefits to the airway from mandibular advancement, resulting in the further narrowing of the pharyngeal airway.⁵

Giannasi et al (2008), reported an adjustable PM Positioner, a mandibular repositioning appliance was fitted on to maxillary complete denture. A polysomnogram (PSG) both prior and with the oral appliance "in situ" was utilized to evaluate the effect of the adaptation of the adjustable PM Positioner fixed onto a maxillary full denture in decreasing the apnea hypopnea index.¹⁶

Kurtulmus & Cotert (2009), described a clinical and laboratory method for producing a new non-adjustable, acrylic monobloc functional splint combining a tissue borne mandibular advancement splint (MAS) and a tongue retaining device with custom-made tongue-tip housing for an edentulous patient with obstructive sleep apnea.¹⁷

Piskin et al (2010), reported a fabrication method and treatment efficacy of an acrylic, monobloc, modified mandibular advancement device (MAD), which acts by displacing bulky masseter muscles laterally, to provide more space for tongue on totally edentulous patient with severe OSA.¹⁸

Implant supported oral appliances for completely edentulous patients

Hoekema et al (2007), described an implant retained two piece mandibular repositioner appliance (MRA) as a viable treatment modality of edentulous obstructive sleep apnea hypopnea syndrome (OSAHS) patients. The MRA therapy was performed with a modified version of the Thornton adjustable positioner where the patients titrate the required amount of mandibular advancement. In the maxilla, the MRA was retained by the suction force of the upper denture. In the mandible, the MRA

was retained by the bar construction and a clip attachment that was incorporated into the duplicate of the lower overdenture. Patients were instructed to wear the MRA instead of their dentures whenever they slept. For patients requiring an implant retained MRA in the maxilla, two implants can be placed in the canine regions, as placing implants in maxillary posterior region involves more morbidity and prolonged treatment protocol. These two implants can be provided with ball attachments that may subsequently be used for retention of an overdenture and MRA, thereby minimizing surgical intervention.¹⁹ Flanagan (2009), reported on snore reduction appliance that can be constructed for the atrophic mandibular edentulous patient by using two endosseous implants to retain a complete mandibular denture and, in turn, an overlying bimaxillary removable snore reduction appliance.²⁰

Oral appliances in partially edentulous patients

Ogawa et al (2009), reported a study on fabrication of a monobloc oral appliance with a denture base as a promising tool for the treatment of OSAS patients with multiple missing teeth and by utilizing 70% of the maximum protrusion of the mandible.²¹ Giannasi et al (2010), reported that oral appliances such as the PM Positioner are an alternative for treating obstructive sleep apnea in partly edentulous patients.²²

Future perspectives

The interplay between anatomic, functional and neural factors that influence the upper airway patency during wakefulness and sleep is still unclear. This may be due to the missing data linking sleep studies using polysomnography and three-dimensional imaging studies performed during wakefulness and natural sleep conditions. Much research is required in the following aspects of dental sleep medicine:

- Screening of edentulous patients for OSA risks using portable devices.
- 3-D Imaging studies of upper airway during sleep.
- 3-D imaging studies of upper airway with nocturnal complete denture wear.
- Longitudinal prospective sleep studies on effect of tooth loss as a risk factor of OSA.

Conclusion

Although the role played by the prosthodontists is still in its infancy, there is much to learn and understand in the rapidly evolving field of sleep medicine. The growing interest of prosthodontists in sleep medicine has contributed immensely towards effective prevention and treatment of obstructive sleep apnea (OSA) and sleep bruxism. However, consensus will emerge eventually on the prosthodontic treatment modality to be employed in these patients. Further research by prosthodontists involving advanced imaging and sleep studies will aid in tailoring the appropriate therapy for each patient based on his/her individual requirement.

Conflicts of interest

All authors have none to declare.

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