

Obstructive Sleep Apnea and Role of Orthodontics – A Brief Overview

Jiju M.^{1,*}, Mohd. Tariq², Sandhya Maheshwari³, Aditi Gaur⁴, Yumna Qamar⁵

^{1,5}Junior Resident, ^{2,3}Professor, ⁴Senior Resident, Dept. of Orthodontics, Aligarh Muslim University, Aligarh

***Corresponding Author:**

Email: ms.jiju@gmail.com

Abstract

Obstructive sleep apnea is a medical condition that can affect an individual's life quality. Obstructive sleep apnea, at times can cause both physical and mental trauma to the patients. Proper treatment has to be given since it can change to a fatal medical condition if left ignored. OSA is characterized by upper airway obstruction, temporary cessation of breathing (apnea) or shallow breathing (hypopnea), associated with disturbed sleep. Snoring can be a regular symptom. A proper diagnosis and management is very much essential in such individuals to provide them a better life quality. The main aim of this article is to provide an overview of Obstructive sleep apnea- its clinical features, diagnosis and clinical management. Also, emphasis has given to explain the role of orthodontist in Obstructive sleep apnea.

Keywords: Obstructive sleep apnea, Sleep apnea, Snoring, Sleep disorder, Breathing disorders.

Introduction

The prime purpose of any medical treatment, in one or the other sense, is improving the quality of an individual's life. Obstructive sleep apnea is a medical condition that can affect an individual's life quality. Obstructive sleep apnea, at times can cause both physical and mental trauma to the patients. Treatment has to be provided since it can be a fatal medical condition if left ignored. OSA was first described by Charles Dickens in 1837. However it was only in 1956 that Sidney Burwell carefully documented a case of an OSA patient. The first description of this disorder was recorded in 1965.⁽¹⁻³⁾

The major symptoms of OSA include upper airway obstruction, temporary cessation of breathing (apnea) or shallow breathing (hypopnea), associated with disturbed sleep. The upper airway obstruction causes snoring sound, produced by the vibration of soft palate or other oropharyngeal tissues. If cessation of breathing occurs for 10 seconds or more, is termed as apnea [Greek word meaning without breath]. When a person is experiencing 30 or more apneic episodes during the course of a seven hours sleep, resulting in excessive sleepiness during the day time, he/she can be considered as an obstructive sleep apnea patient. This condition can occur at any age with increased incidence rate in adults.⁽¹⁻³⁾

This article emphasizes to give a simple and brief description of OSA, and to highlight the role of an orthodontist in the overall diagnosis and treatment planning of the condition.

Pathophysiology:⁽⁴⁻¹⁰⁾

The underlying pathophysiology of OSA is considered multifactorial. It may vary considerably between individuals. Several predisposing risk factors are identified and include obesity, male sex, ageing, micrognathia, retrognathia, macroglossia, alcohol consumption, enlarged tonsils, adenoids etc. Improved

understanding of the underlying pathophysiology is important for the novel treatment strategies of OSA.

OSA is characterized by recurrent collapse of the pharyngeal airway during sleep, resulting in substantially reduced (hypopnea) or complete cessation (apnea) of airflow inspite of ongoing breathing efforts. These disruptions to breathing eventually lead to intermittent blood gas disturbances (hypercapnia & hypoxemia) and surges the sympathetic activation.

Obesity is considered as the main epidemiologic risk factor along with increase in body mass index, central accumulation of adipose tissue.

As explained earlier pathophysiological causes of OSA is likely to vary between individuals. Important components include upper airway anatomy, ability of the upper airway dilator muscles to respond to respiratory challenge during sleep and the stability of the respiratory control system.

Literature suggests that the pathophysiology of OSA is mainly genioglossal, supported by the fact that the individuals with OSA have impaired genioglossal function. Also the further studies suggest that the generalized hypotonia of the dialating muscles of the upper airway can lead to the total collapse of the upper airway. Even though the posterior pharyngeal airway contributes much in the occurrence of the OSA, nasal airway can also play an important role in total airway occlusion. Any occurrence of nasal obstruction increases the air flow resistance which results in increased inspiratory effort and greater negative pressure in the pharyngeal airway, which eventually leads to the collapse of airway.

Symptoms:⁽¹¹⁻¹⁵⁾

Obstructive sleep apnea causes many symptoms which affects the quality of life. These includes

- Snoring (Common finding)
- Apneic episodes (Choking, Gasping, etc.)

- Excessive sweating
- Restless leg syndrome, increased body movements and restless sleep
- Nocturnal and day time enuresis
- Sleep terrors
- Mouth breathing
- Adenotonsillar hypertrophy
- Chronic nasal congestion/rhinorrhea
- Dry mouth and sore throat
- Morning headache
- Fatigue
- Excessive day time sleepiness
- Hyponasal speech
- Infraorbital venous congestion
- Mood changes: irritability, low frustration tolerance, impatience, depression, anxiety and a negative sense of well being
- Cognitive impairment
- Poor concentration
- Distractibility

Symptoms of OSA in children includes

- Bed wetting
- Chocking or drooling
- Sweating a lot at night
- Inward movement of ribcage during expiration
- Learning and behavioural disorders
- Problems at school
- Sluggishness or sleepiness
- Snoring
- Bruxism
- Restless in bed

Obstructive sleep apnea can be fatal if remains undiagnosed. Because of multiple apnea episodes during sleep, circulation of unsaturated oxygen takes place to the vital organs including brain. This may lead to fatal conditions like stroke, congestive cardiac failure and cardiopulmonary disorders. Some incidents of death were reported due to road traffic accidents in those patients with OSA because of excessive daytime sleepiness.

Diagnosis:⁽¹¹⁻¹⁵⁾

Proper history taking and thorough clinical examinations of those patients who are seeking orthodontic treatment have to be done. A proper history taking itself reveals the presence of OSA symptoms and thereby helps in proper diagnosis. Clinical examination has to be done which will help in the identification of the mentioned predisposing features. After thorough history taking and clinical examinations, if OSA is suspected, the orthodontist has an option of further evaluating the radiographs especially the lateral cephalogram, which are included in the routine diagnostic records for orthodontic treatment. Analysis of lateral cephalogram gives a clear cut idea about the mandibular and maxillary retrognathia, enlargement of tonsil and adenoids which all are the major contributing factor for OSA.

If the suspicion of OSA strengthens then combined discussion with physician has to be done and for the diagnostic confirmation, an overnight polysomnography, referred as sleep study has to be conducted. Overnight polysomnography in a sleep laboratory, which generally incorporates recording of electroencephalogram, electrooculogram, snoring (microphone), thermistor, electrocardiogram, pulse oximetry, and tibialis anterior electromyogram. The resulting data following a sleep study is the Respiratory Disturbance Index (RDI). This is a type of complex index. This complex index measures the number of apnic (total cessation of breathing) and hypopnic (shallow breathing) events per hour of REM and non REM sleep. It can be described with an example. Someone who has an RDI of 30 has 30 apnic or hypopnic events an hour. The range of RDIs is as follows. RDI < 5 Normal; RDI 5-15 Mild; RDI 15-30 Moderate; RDI > 30 Severe.

Apnea hypopnea index (AHI)⁽¹⁶⁻¹⁸⁾ is used to assess OSA, along with RDI. The apnea-hypopnea index is an index used to assess the severity of sleep apnea. AHI is based on the number of complete cessations (apnea) and partial obstructions (hypopnea) of breathing occurring per hour of sleep.

The Classification of Sleep Apnea Based on AHI for adults

- Normal: fewer than 5 events per hour
- Mild sleep apnea: 5-14.9 events per hour
- Moderate sleep apnea: 15-29.9 events per hour
- Severe sleep apnea: greater than 30 events per hour

Children are considered to have sleep apnea if they have more than 1 abnormal breathing event per hour of sleep.

The use of lateral cephalometric radiographs to evaluate the upper airway is of limited use. This is mainly because these lateral cephalograms provide 2-dimensional images of the nasopharynx. Actually nasopharynx is complex 3-dimensional anatomic structure. Linder-Aronson found a high level of correlation between the results of posterior rhinoscopy and radiographic cephalometrics in the assessment of adenoid size. A good picture of the size of the nasopharyngeal airway can be provided by lateral skull radiographs.

Notwithstanding the considerable attention given to the growth of the pharynx, the statement of Scott (1955) "less is known about the growth of the pharyngeal region than any other part of the face" is still largely true. With development of new technologies like three dimensional radiographs like CT, it is feasible to obtain 3-dimensional knowledge of the airway anatomy.

Treatment:^(19,32)

Over years many different types of treatment modalities are introduced for the management of obstructive sleep apnea, which includes

- Behavioural modification

- Weight loss in obese individuals
- Avoid consumption of alcohol
- Changing the sleeping position from sleeping on stomach or one side to sleeping on back
- CPAP(Continuous positive air pressure)
- Upper airway simulator
- Upper airway surgery
- ~UPPP/UP3
- ~Tonsillectomy
- Skeletal surgery
- Oral appliances
- Microimplant based orthodontic mandibular advancement

CPAP (Continuous positive air pressure):⁽¹⁹⁻²¹⁾

CPAP (Fig. 1) is considered as the gold standard in the management of moderate to severe types of obstructive sleep apnea. Mechanism of action is simple. It sends a continuous stream of air under pressure which helps to maintain a positive air pressure and thereby preventing the air way collapse and keeping it patent for a smoother air flow. But CPAP requires the usage of a mask interface, sealed tubing and a device connected to a power source which makes loud noise. Patient has to worn the whole setup throughout the sleeping time and because of this complexity, limited acceptance by patients and leads to suboptimal treatment adherence. Even certain patient's tolerance levels to CPAP are also limited. Because of all this reasons an alternate to CPAP is well accepted by the patients. And here comes the "role of oral appliances and orthodontists", significant.

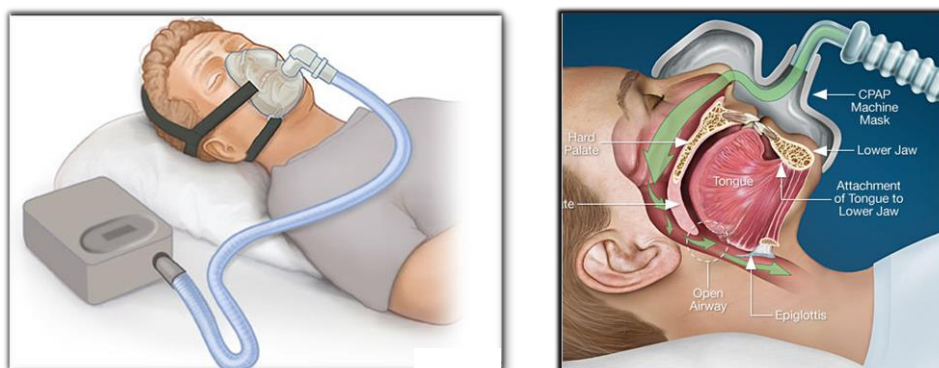


Fig. 1: CPAP

Surgery:⁽²²⁻²⁴⁾

Different surgical techniques used for the management of OSA are described which includes

- Upper airway simulator
- Somnoplasty
- Soft tissue surgery
- Skeletal surgery

Upper Airway Simulation:⁽²²⁾

Simulations of airway behavior may represent a non-invasive means of OSA management. Can be used as a non invasive technique in those patients who are not able to tolerate CPAP.

Upper Airway Surgery:

UPPP (uvulopalatopharyngoplasty) is a procedure that removes soft tissue in the back of the throat and palate, increasing the width of the airway at the throat opening (throat reconstruction) walls (throat reconstruction). Unfortunately, the success rate for this approach to sleep apnea is only 40% because obstructions at other sites are not affected. Also chances for recurrence are very high.

Skeletal Surgery:

Surgical correction of the jaw position is the most effective treatment modality for OSA considering the long term stability. Skeletal surgery involves maxillary and mandibular advancement along with maxillary and mandibular expansion. For effective and long term results, studies suggest that the orthognathic surgical advancement of mandible has to be more than 10mm. This clearly indicates the need for maxillary advancement also. In patients with increased lower anterior facial height, reduction genioplasty can be done. Also in patients with retrognathic mandible advancement genioplasty can be done which further reposition the genioglossal muscle attachment and eventually aids in the forward positioning of the tongue.

Role of Orthodontists and Oral Appliances:⁽²²⁻²⁹⁾

Oral appliances can be design as either removable or fixed depending upon the individual's patient compliance. The basic idea of giving oral appliances is simple. Literature suggests that in majority of OSA patients, retrognathic mandible, tongue interference and narrow airway contributes much for the development of the symptoms. Oral appliances help in the advancement

of mandible and tongue and thereby prevent the collapse of the upper airway.

Indications:

Oral appliances are mainly indicated in those patients with mild obstructive sleep apnea with either failure or rejection of behavior modification therapy which includes weight reduction, changing the overnight sleeping position and posture etc. In moderate to severe OSA patients the recommended treatment modality is CPAP. However as explained majority of patients rejects the treatment because of its complexity or because of inability to tolerate. Oral appliances are indicated in such instances. Also oral appliances are recommended in cases where patients are not ready for any surgical treatment like removal of enlarged tonsils, adenoids, maxillary and mandibular advancement.

Types of oral appliances:

Mainly there are two types of oral appliances used for the management of obstructive sleep apnea.

- Tongue retaining device (TRD)
- Mandibular advancement devices (MAA)

Tongue retaining device (TRD)

TRD is a simple splint like intra oral appliance which is designed for holding the tongue (Fig. 2) and thereby preventing its fall across the posterior pharyngeal wall. This helps in maintaining the airway patency and thereby prevent the airway collapse. TRD is only effective in those patients with open airway without any obstruction other than the obstruction caused by the falling tongue.



Fig. 2: Tongue Retaining device

Mandibular advancement appliances (MAA)

MAA is the most common type of intra oral appliance used for the management of OSA. It protrudes the mandible forward, thus preventing the upper airway collapse during sleep. Mechanism of action is simple. The appliance has to be worn only during sleep and it helps to keep the airway open by repositioning the mandible, tongue, soft palate and uvula. Currently three categories of appliances are available. Modified Twin block appliance can be used as mandibular advancement appliance. (Fig. 3)

First category: One piece appliance which does not have the ability to advance the mandible incrementally

Second category: Two piece in design and the appliance has the potential for the incremental advancement of mandible.

Third category: This appliance design allows the incremental advancing of mandible as well the lateral movement of mandible.

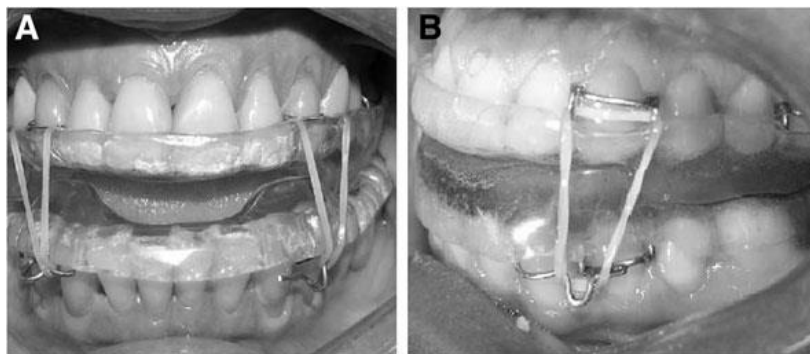


Fig. 3: Modified Twin block appliance

Advantages:

Wearing of oral appliances results in significant reduction of apnea in patients with mild to moderate OSA. Also in patients with severe OSA, airflow improvement is satisfactory. It helps in reducing the frequency as well the loudness of snoring in patients with OSA. Compared with CPAP which use complex setup, intra oral appliances are well accepted by the patients. It is easy to use compared to CPAP and also it is easily portable which makes the patients more compliant with this treatment modality.

Disadvantages:

All types of the intra oral appliances used for the management of OSA uses dentition as anchorage. Sometimes it can extend to the soft tissue causing trauma to the tissues. Also the mandibular advancement appliances exert reciprocal forces on the dentition which will result in the development of acute symptoms and also long term skeletal and dental side effects. Long term usage of the mandibular advancement appliance also results in the development of

temporomandibular joint symptoms. However the development of all these negative effects depends upon the amount of mandibular advancement, type and design of appliance, frequency and duration of follow up etc. Also during the acclimatization period mild and self limiting side effects can be developed like excessive salivation, mouth dryness, tooth pain, gum irritation, headaches and temporomandibular discomfort.^(30,31)

Micro Implant Based Orthodontic Mandibular Advancement:

Microimplant-based mandibular advancement therapy can be used as an alternative treatment modality for OSA patients who cannot tolerate continuous positive airway pressure and oral appliance therapy.⁽³²⁾

Conclusion

Obstructive sleep apnea is characterized by the episodes of apnea along with sleep disturbances. Victim feels choking sensation, gasping feeling, and excessive sweating after waking suddenly from sleep. Also patient's quality of life gets affected with increased day time sleepiness, mood disorders, poor concentration and memory problems. If OSA is suspected after proper history taking and clinical examination, a medical consultation is recommended and the patient can be managed with thorough interdisciplinary discussions and treatment planning.

References

- Guilleminault, Christian, 1985, "Obstructive sleep apnea", *Med Clin, N.A.M* 69:1187-1203.
- Guilleminault, Cand Dement, W.C. 1978 "sleep apnea Syndromes," Kroc Foundation Series, Vol 11, New York Alan R. Liss.
- Kales, A, Bider, E.O. Cadieux, R.J. et al/1984, Sleep apnea in a hypertensive population. *Lancet*. 2.1005-1008.
- Cistulli PA, Sullivan CE "Pathophysiology of sleep apnea" In: Saunders NA, Sullivan CE, eds. Sleep and breathing, New York, NY: Marcel Dekker, 1994:405-448.
- Bilwise, D.I, and Pascualy, R.A 1984, "Sleep related respiratory disturbance in elderly persons", *Compr Ther*, 10(7):8-14.
- Cortese S, Konofal E, "Sleep and alertness in children with attention deficit/hyper activity disorder: a systemic review of literature." *Sleep* 2006;29:504-511.
- Peltinaju T. "The effect of mode of breathing on craniofacial growth-revisited", *Eur J Orthod* 2007;29:426-429.
- Alexandar, J.K. Guthrie, A.E., 1959 "Lung volume changes with extreme obesity". *Clin. Res* 7:171-176.
- Schwab RZ, Gupta KB. "Upper airway soft tissue anatomy in normal and patients with sleep disordered breathing: Significance of the lateral pharyngeal walls" *Am J Respir; criti care med* 1995;152:1673-89.
- Alexander J.K Amad, H, "Observations on some clinical features of extreme obesity, with particular reference to cardiorespiratory effects", *Am J. Med*. 32:512-517.
- Moran, W.B and Orr, W.C 1985 "Diagnosis and management of obstructive sleep apnea", Part-II *Arch Otolaryngol*. 111(10):650-658.
- Bornstein SK, "Respiration during sleep polysomnography." Addison – Wesley; 1982 p.183.
- Dillon JE, Blunden S "Diagnosis and obstructive sleep apnea in children before and one year After adenotonsillectomy". *J Am Acad child Adolesc Psychiatry* 2007;46:1425-36.
- Gastaut H, Tassinari CA, Duron B, "Polygraphic study of diurnal and nocturnal (hypnic and respiratory) episodal manifestations of Pickwick syndrome". *Rev Neurol (paris)* 1965;112:568-579.
- Cistulli PA, Grunstein RR. "Medical devices for the diagnosis and treatment of obstructive Sleep Apnea". *Expert Rev Medical Dev* 2005;2:749-763.
- Fishman's Pulmonary Diseases and Disorders, 5th edition.
- P. John Kimoff, Murray and Nadel's Textbook of Respiratory Medicine, 6th edition.
- Reginald H B Goodday "Current therapy in oral and maxillofacial surgery", 2012.
- Barnes M, McEvoy RD, "Efficacy of positive airway pressure and oral appliance in mild to moderate obstructive sleep apnea" *Am j Respir Crit Care Med* 2004;170:656-664.
- Weaver TE, Chasens ER "Continuous positive airway pressure treatment for sleep apnea in older adults", *Sleep Med Rev* 2007;11:99-111.
- Mc Ardle N, Devereux G "Long term use of CPAP therapy for sleep apnea/ hypopnea syndrome" *Am J Respir Crit Care Med* 1999;159:1108-1114
- Moyin Zhao, Tracie Barber, Peter A, Kate Sutherland. "Simulation of upper airway occlusion without and with mandibular advancement in obstructive sleep apnea using fluid- structure interaction" *Journal of Biomechanics* 46(2013)2586-2592.
- Wei JL, Smith HJ. "Improved behavior and sleep after adenotonsillectomy in children with sleep disordered breathing" *Arch Otolaryngol Head Neck Surg* 2007;133:974-979.
- Thawley, Stanley E 1985 "Surgical treatment of obstructive sleep apnea" *Med. Clin. Of N. Am* 69;1337-58.
- Hamada T, Ono T "Mandibular distraction Osteogenesis in skeletal class II patient with obstructive sleep apnea" *Am J Orthod Dento facial Orthop* 2007;131:415-425.
- Mimi Yow, "Overview of oral appliances and managing the airway in obstructive sleep apnea". *Semin orthod*. 2009;15:88-93.
- Cistulli PA, Gotsopoulos H. "Treatment of snoring and obstructive sleep apnea with mandibular repositioning appliances" *Sleep med rev* 2004;8:443-57.
- Ferguson KA, Rogers, "Oral appliance for snoring and obstructive sleep apnea: review" *Seep* 2006;29:244-262.
- Ng ATm, Gotsopoulos H "Effect of oral appliance therapy on upper airway collapsibility in obstructive sleep apnea" *Am J Respir Crit Care med* 2003;168:238-241.
- Lowe AA "Oral appliance for the treatment of snoring and obstructive sleep apnea" *J Can Dent Assoc* 1999;65:571-574.
- Oktay H, Ulukaya E, "Maxillary protraction appliances effect on the size of the upper airway passage" *Angle orthod* 2008;78:209-214.
- Usumez S, Orhan M "Effect of rapid maxillary expansion on nocturnal enuresis" *Angle orthod* 2003;73:532-538.
- Kuro J, Modin H "Orthodontic maxillary expansion and effect on nocturnal enuresis" *Angle orthod* 1998;68:225-232.
- Robertson CJ, "Dental and skeletal changes associated with long term mandibular advancement", *sleep* 2001;24:531-537.
- Marklund M. "Predictors of long-term orthodontic side effects from mandibular advancement devices in patients

- with snoring and obstructive sleep apnea,” *Am J Orthod Dentofac Orthop* 2006; 129:214-221.
36. Joachim Ngiam and Hee-Moon Kyung, Microimplant-based mandibular advancement therapy for the treatment of snoring and obstructive sleep apnea: a prospective study, vol.82, issue 6, *angle ortho*.