ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 9, Issue, 01, pp.44791-44795, January, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

REVIEW ARTICLE

OBSTRUCTIVE SLEEP APNEA- A POSSIBLE DOMAIN OF ORTHODONTICS

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ARTICLE INFO

Article History:
Received 14th October, 2016
Received in revised form
22nd November, 2016
Accepted 26th December, 2016
Published online 31st January, 2017

Key words:

Obstructive sleep apnea (OSA),
Orthodontic treatment,
Breathing disorder, Apnea.

ABSTRACT

Sleep related breathing disorders specially obstructive sleep apnea is a multifactorial complex condition associated with high co-morbidity and mortality rates. Obstructive sleep apnea is associated with decreased oxygen saturation due to mechanical obstruction at different level of upper airway associated with anatomical deviation like maxillary or mandibular retrognathism, large tongue, elongated soft palate inferior hyoid position and severe malocclusion. It affects both children and adults equally and causes neuropsychological impairment, metabolic and cardiovascular co-morbidity, sexual dysfunction, compromised economic potentiality and quality of life. Epworth sleepiness scale data, polysomnogram along with cephalometric radiographs, 2D-3D scans for anatomical variations and clinical evaluation are reliable measures to detect Obstructive Sleep Apneas. Multi disciplinary approaches from non invasive to advanced surgical procedures provided by specialty like ENT, Chest medicine, Sleep specialist, Maxillofacial surgeon and Orthodontist can serve better treatment to OSA patient. Orthodontic specialty has the opportunity to detect anatomical deviation early and can provided growth modifications with different non-invasive better compliant oral appliances for mild to moderate OSA patients. Classical treatment ranges from behavioral modification and MAD's like oral appliances for mild to moderate OSA situation. Continuous positive airway pressure (CPAP) is the most effective measure for moderate to severe conditions .In severe situation different surgical approaches are followed with variable responses. This article reviews the current basic scientific knowledge about Obstructive Sleep Apnea including definition, prevalence, riskfactor, pathophysiology, diagnosis, complication and conventional & advanced treatment modalities with special emphasis on orthodontic mode of treatment.

Citation: Dr. Shyamal Bar, Dr. Shabnam Zahir and Dr. Jiban Mishra, 2017. "Obstructive sleep apnea- a possible domain of orthodontics", *International Journal of Current Research*, 9, (01), 44791-44795.

INTRODUCTION

Good quality sleep ensure several functions, these include physical recovery, biochemical refreshment, memory consolidation, normal growth and development and psychological well being (Lavigne, 2009). Deviation from normal sleep may affect individual health considerably termed as sleeping disorders. According to International classification of sleep disorders (ICDS-3) re-structured in 2014 there are six different categories of problems, namely Insomnia, Sleep related breathing disorders (Sleep Apnea), Hypersomnomlence centre disorders, Circadian rhythm sleep-wake disorders, Parasomnias, Sleep related movement disorders (International classification of sleep disorders, 2014). Sleep apnea described by Gastuts research group in seventies are of 3types, obstructive, central and mixed apnea. Obstructive sleep apnea (OSA) is caused by partial or complete obstruction at different levels of the upper airway causes reduction (hypopnea) or cessation of (apnea) air flow. Due to lack of adequate alveolar ventilation, oxygen saturation may drop and partial pressure of CO_2 may increase. Snoring and sleep fragmentation are common with OSA that can be graded as mild, moderate and severe (American Academy of Sleep Medicine task Force, 1999). Adults and children are equally affected but prevalence, etiology and pathophysiology of the disorder differ from one group to another. Incidence increases with age. Anatomic factors that contribute to OSA are maxillary and mandibular retrognathism, increased lower facial height, large tongue, elongated soft palate, inferiorly positioned hyoid bone thereby increasing risks of developing a significant malocclusion. This point out how critical the role of orthodontist can be in diagnosing and treating OSA. Furthermore, OSA isassociated with neuropsychological impairment, sexual dysfunction, metabolic and cardiovascular co-morbidities and causes an increase in mortality. Quality of life and economical potential are also affected. Snoring affects the sleeping pattern of the partner as well. Frequent arousals at

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night and resulting relative sleep deprivation can cause excessive day time sleepiness, loss of concentration and motor vehicle accidents (Giannasi, 2014). Therefore, OSA is regarded as a public health condition and increases the consumption of health care resources. Continuous positive airway pressure (CPAP) is considered a golden standard treatment. Other modalities like maintaining sleep hygiene which involves withdrawal from alcohol and other drugs, proper body position and slimming[5].Oral appliances have been recommended due to their non invasive low cost relative comfort and ease of use nature and greater patient compliance (Epstein, 2009; Kato, 2000 and Randerath, 2002). Surgical procedures for upper airway soft tissue changes and maxilla – mandibular advancement are other alternative. Hence OSA treatment requires a multidisciplinary approach. Orthodontist, sleep specialists and surgeon should all be involved in managing and treating OSA.

OSA Epidemiology

Prevalence

According to the Wisconsin sleep cohort study, the estimated prevalence of moderate to severe sleep breathing disorder in USA ranges 3% to 17% in adults depending on sex and age. Incident increases among elderly individual irrespective of sexes. Epidemiological studies in the UK estimated that 5.7% of men and 1.2% women in age group of 35-69 have obstructive sleep apnea syndrome. African studies shows that obstructive sleep apnea prevalence ranges from 5%-9% in general population. The estimated prevalence of sleep breathing disorder in urban Indian men are 19.5% and 7.5% which is striking and may have major public health implication in a developing country like India (Orthodontics, 2009). De Backer (2013) reported that epidemiological studies investigating the prevalence of OSA are all biased because there is a lack of uniform definition (Hakima Aghoutan, 2015).

Risk factor

Different literature indicate that risk factors for OSA include obesity, upper airway and craniofacial abnormalities, age, gender, alcohol consumption and smoking. In non obese patients craniofacial abnormalities like micrognathia and retrognathia considered as a risk factors leading to OSA (Johnson, 2002). Aging also associated with higher OSA incidence. Prevalence of OSA also shows some ethnic variation. Other factors such as heredity, hormonal changes, sedative hypnotics and supine sleep position have also been described as risk condition for developing OSA (De Baker, 2013 and Lurie, 2011).

Mortality and Morbidity

Epidemiological data have shown a strong association between untreated obstructive sleep apnea and incident of cardio and cerebrovascular morbidity and mortality (Barker, 2014). A recent review of OSA in adults reported an increased risk of morbidity and mortality associated with OSA which reached its peak at 55 years of age and disappear after 70 years (Dauviliers, 2010).

OSA Pathophysiology

In recent years the understanding of the pathophysiology of sleep breathing disorder has improved. Central nervous system regulation of breathing is now recognized as a significant contributor to pathogenesis of OSA. Multifunctional complex and dynamic neuro-mechanical system of upper airway anatomy is the other important factor for developing OSA. In normal individuals in awake state the upper airway dimensions remain practically constant throughout inspiration by neuromotor mechanism. However, during sleep, neuro-motor tone decreases and upper airway resistance increases considerably especially in sleep onset and REM stages. These physiologic variations are counteracted by a reduction of diaphragm and intercostals muscles activity and thus a decrease in inspiratorypressure. This tendency for the human upper airway to collapse predisposes it to abnormal deformation during sleep, mainly in susceptible individuals (Ayappa, 2003). OSA pathophysiological factors are usually divided into three categories. Different studies have demonstrated that patient with OSA have significant craniofacial and upper airway abnormalities. Anatomical abnormalities include retroposition of the mandible and maxilla, shorter mandibular body length, longer anterior facial height, steeper and shorter anterior cranial base (Liu, 2000). Non anatomic factors are principal factors related to the collapsibility. They are either mechanical or neurological like head posture, vascular supply to the mucosa and tissue surrounding the airway and arousal threshold.OSA has been shown to be increased significantly within families. Genetic factors likely to determine upper airway anatomy, neuromuscular activity and ventilatory control stability and susceptibility to OSA.

OSA Diagnosis

Aimed at maximum standardization and better care of the patient. Standard practice for recording sleep and breathing and evidence – based recording of abnormal parameters are essential. Despite high estimated prevalence, awareness of OSA remains insufficient in the communities. Health care professionals including orthodontist should not disregard the risk of OSA and should detect and diagnose this disorder. OSA screening should be based on sleep oriented history and physical examination in conjunction with objective tests. When diagnosed, OSA severity level must be determined for effective treatment decision (Epstain, 2009). Excessive day time sleepiness (EDS) caused by sleep fragmentation due to frequent arousals at night. Epidemiological studies estimate EDS prevalence at 8-30% in general population. Currently the most useful instrument to detect EDS is the Epworth Sleepiness Scale (Johns, 1999). This questionnaire provides sleep propensity measure and good test–retest reliability. Other objective laboratory sleep tests like multiple sleep latency test or maintenance of wakefulness tests are also used but these are costly and time consuming. The presence of snoring alone is a poor predictor of OSA. Thus it must be correlated with other accompanying clinical features. Similarly snoring absence does not exclude OSA. Talking to the partner and family members can be very helpful. Patient may also report poor sleep quality, morning headache, impaired memory, failed concentration, nocturia and depression (Lavigne, 2009). Obesity is the main predisposing factors for OSA. Increased BMI is closely correlated to OSA likelihood and severity. Clinical examination should include anatomical features of craniofacial and oropharyngeal structures as they can compromise airway patency. Particular attention should be paid to upper airway narrowing signs such as tonsilar hypertrophy especially in children, nasal obstruction,

macroglosia with dental impression at the edge of the tongue, elongated uvula or soft palate inflammation (Ramsey, 2007). During examination other important findings should be checked like retrognathia, micrognathia, maxillary deficiency with high arched or narrow palate, longer anterior facial height, cranial base abnormality or inferior hyoid bone position. Cephalometric radiograph enable to detect quantitive measures of these features (Prabhat, 2012). Medication history of the patient is very important particularly regards to drugs that are associated with OSA, like sedatives, anxiolytic and muscle relaxants. These medicines causes decrease respiratory drive. Other medication that impare sleep onset or maintenance of sleep like anti-cholesterol appetite supplements, benzodiazepines, caffeine, nicotin, diuretics are also should be counted. Hypertension itself has an important contribution to developing OSA.

Objective Testing

To establish OSA severity objective testing is required. Two acceptable methods follows, they are laboratory polysomonography (PSG) and home testing with portable monitors (PM). Polysomonography is considered the golden standard method for diagnosing OSA. It records sleep breathing pattern and oxygen saturation over night via a minimum of 12 channels of physiological signal such as electroencephalogram, electrocardiogram, electromyogram, oronasal air flow, electro-occulogram, respiratory efforts, body position and oxygen saturation. A single night PSG is sufficient to make an appropriate OSA diagnosis and severity detection. Home testing by portable monitors (PM) offer greater convenience to the patient but this procedure has some limits related to the lack of supervision and its reliability (Yaggi, 2010). Other modalities like 2D or 3D imaging of craniofacial and airway studies are also done for understanding the pathogenesis of sleep-breathing disorder and planning of treatment.

Treatment of OSA

Theraputic approach of OSA requires interdisciplinary communication among healthcare professionals and long term management with a regular follow up. Treatment modalities of OSA can be divided into surgical and non-surgical treatment along with associated adjunctive therapies.

Non surgical Treatment of OSA

Primarily includes continuous positive airway pressure (CPAP), behaviour modifications and oral orthodontic appliances.

Continuous Positive Airway Pressure

CPAP consider the golden standard for moderate to severe OSA treatment since it is introduced by Sullivan in 1981 (Sullivan, 1981 and Ferguson, 1996). Compressed air is pumped through oral, nasal or oronasal interface by positive pressure across the airway walls during sleep to keep it open. Studies found that CPAP improves sleep measurement in patients considerably as it effectively reduce AHI and arousal index scores and increase the minimum oxygen saturation. Successful therapy with CPAP depends greatly on individual patient acceptance and compliance (Qaseem, 2013 and Hoffstein, 1992).

Behaviour modification

Patient with OSA are encouraged all practices that enhances life routines and sleep hygiene. It includes weight loss, positional therapy and avoidance of smoking, alcohol and sedatives prior sleep. Weight loss found to be very effective to improve OSA condition. As sleeping in supine position can affect airway size, positional therapy like alarm, pillow, backpack or tennis ball is an effective secondary therapy for OSA.

Oral Orthodontic Appliances

Oral Orthodontic appliance therapy may be considered regardless of severity of OSA. It is potentially making a valid contribution to treatment of OSA (Guilleminault, 2007). The results of the studies suggest that an early approach with oral appliances may prematurely modify nasal breathing and respiration. Pierre Robin was the first orthodontist to have used oral appliances in the 1900's for glossoptosis. Since the 80s oral appliances (OA) used as a non invasive treatment for OSA. It is effective in reducing the apnea and hypopnea index (AHI), improving oxygen saturation during sleep and reducing snoring. Patients with mild to moderate OSA who do not tolerate to CPAP or those who refuse surgery are good candidate for oral appliance therapy (De Almeida, 2008). Both mandibular advancement device (MADs) and tongue retaining devices (TRD) are most commonly used oral appliances. But MAD described and evaluated extensively. MAD covers the upper and lower teeth and hold the mandible in an advanced position with respect to the resting position. They are worn during sleep and they act by enlarging obstructed upper air way by moving the mandible and tongue anteriorly activating the airway dilator muscles. Oral appliances have some side effects like dry mouth, excessive salivation, jaw discomfort, myofacial pain and TMJ problems. The academy of Dental Sleep Medicine suggested the use of cephalograms as diagnostic aid at the initial dental examination of every patient receiving OA treatment.

Orthodontic treatment &OSA

Orthodontist are the qualified health care professionals to identify and treat craniofacial abnormalities and guide the growth of the craniofacial complex to structurally address the symptoms of OSA. Orthodontic improvement of dentofacial morphology have a positive impact on OSA. As orthodontists are ideally positioned to identify and potentially prevent craniofacial abnormalities, particularly younger individuals, help them to detect risk factors or signs related to OSA. Planned preventive and interceptive orthodontic treatment for children and inter disciplinary management for adults can effectively improve OSA condition. Newer oral appliances allow greater lateral jaw movement. Adjustable appliances (Fig. 1, Fig. 2) allow the clinician to titrate the amount of mandibular protrusion in order to obtain an adequate treatment response and patient compliance (Liu, 2011). Maxillary expansion with RME in children or surgically assisted RME for adults effectively increases nasal cavity dimension and reduce OSA symptoms. Orthodontist can also have a role in treatment of nocturnal bruxism (Villa, 2011).

Surgical treatment of OSA

Currently there are numerous surgical approaches used to upper airway treatment in OSA which consists of upper airway

tissue reduction or reconstruction at different levels. Sometimes surgeries done multi-phased or a combination of multi level simultaneous surgeries.

Fig. 1. Medical dental shorting appliance (MDSA)

Fig. 2. Modified titrable mandibular advancement appliance

Surgical treatment associated with OSA involves evaluation of three anatomic sections of the airway for detection of collapse related abnormalities namely;

- The Nose (Alar cartilage deformity, septal deviation, enlarged turbinates, nasal floor constriction)
- The retropalatal area (Lymphoid hyperplasia, retrusive maxilla, long palate)
- The retroglosal area and the Tongue (Mandibular retrognathia)

Powell et al (Sesso, 2007). have created a two phased directed protocol for surgical treatment of upper airway obstruction at several levels in order to avoid unnecessary surgery. Phase I surgery is designed essentially to treat the upper airway soft tissue without dental occlusion or facial skeletal modifications. In persistent OSA cases require Phase II surgery refers to maxilla mandibular advancement osteotomy, which creates more space for the tongue thus enlarging the posterior airway space (Villa, 2011). Uvulopalatopharyngoplasty (UPPP) a procedure that enlarges the retropalatal airway through excision of obstructing tissues of the soft palate, lateral pharyngeal walls and tonsils. Laser assisted uvulopalatoplasty (LAUP) also used in which the uvula and posterior margin of the soft palate are ablated with carbon di-oxide laser to enlarge the retropalatal airways. In Maxillo – mandibular advancement (MMA) procedure, maxilla and mandible moves anteriorly surgically along with their muscular attachments. This increases the tension in the muscles, particularly those which form part of the lateral pharyngeal wall and thus prevents its collapse. A standard advancement of 10-15mm carried out by Le fort 1 osteotomy of the maxilla and bimaxillary saggital split osteotomy (BSSO) of the mandible. Reported success rate is about 89% to 96% (Prinsell, 1999 and Waite, 1995). Complication of MMA have been reported such as neurosensory deficit, infection, bleeding or temporo mandibular joint problems. Due to greater complication related to MMA, CPAP or OAs should generally be suggested ahead of MMA if the patient is consenting (Cartwright, 2001). Palatal implant is a new treatment option for snoring and mild OSA by inserting a biocompatible material into the soft palate to reduce vibration and collapsibility of the soft palate.

Adjunctive treatment

Cochrane review in 2013 showed insufficient evidence to systemic pharmacological treatment for OSA. Topical nasal corticosteroids can be used as primary therapies for OSA. Among newer drugs like Donepezil showing impressive effects on OSA treatment (Mason, 2013). Bariatric surgery also considered an adjunctive treatment to improve OSA by controlling weight.

Conclusion

OSA is a potential pathophysiological condition which affects all age group of subjects. It is associated with alteration of quality of life neurocognitive functions, cardiovascular health and increased morbidity and mortality in affected patients. Polysomnography remains the most common and reliable test for OSA diagnosis along with other imaging modalities for upper airway structures. Treatment modalities of OSA are aimed at increasing life expectancy decreasing disease problems and improving quality of life. CPAP is the commonest treatment modality for treatment of moderate to severe OSA. Oral orthodontic appliances provide best result in mild to moderate OSA patient Other medical or surgical alternative like mandibular advancement appliances or orthognathic surgery do play a role in the treatment of specific cases of OSA but requires strict monitoring due to differences in individual responses. Multidisciplinary approach comprises of Chest medicine, E.N.T, Sleep specialist, Orthodontist and Maxillofacial surgeon should work together for efficient diagnosis and treatment of these patients. In future, more studies should be conducted with larger sample size and with specific inclusion and exclusion of criterias. This will enhance compatibility of studies and will help to establish well designed treatment guidelines for OSA.

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