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RESEARCH ARTICLE

OBSTRUCTIVE SLEEP APNEA: PART I. DIAGNOSIS AND EVALUATION.

Bobby Joseph Babu, Mahesh CM, Rameshkumar PC, Vinay P Reddy, Chandrashekar BS and Harish Koushik.

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Abstract: Obstructive sleep apnea (OSA) is a common disorder that is characterized by repetitive partial or complete cessation of airflow, associated with oxyhemoglobin desaturation and increased effort to breath. 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 co-managing the patients along with a physician or a sleep-specialist. This article discusses the etiology and pathogenesis, clinical features and risk factors, consequences, diagnosis and evaluation of Obstructive sleep apnea.

Key Words : Obstructive sleep apnea, Sleep disordered breathing, Polysomnography, Pickwickian syndrome

Introduction:-

The Greek word apnea means breathless or loss of breath.[1] Sleep-disordered breathing (SDB) encompasses a heterogeneous group of sleep-related disorders that are characterized by abnormal pauses in breathing during sleep. There are two major types of SDB: obstructive sleep apnea (OSA) and central sleep apnea (CSA). Despite the difference in the actual cause of each type, in both cases, people with untreated sleep apnea stop breathing repeatedly during their sleep. Of the two types of sleep apneas characterized, OSA is the most common type, constituting greater than 85% of all cases of SBD; CSA is far less common.[2]

OSA is caused by a physical blockage of the airway; it results from airflow obstruction secondary to upper airway collapse or anatomic airway obstruction, even though the respiratory effort is still present. In the case of CSA, the

airway is not blocked; the brain fails to signal the muscles to breathe and breathing is interrupted by a lack of respiratory effort.[3]

In 1837, Charles Dickens described an obese hypersomnolent boy named "Joe" in the Posthumous Papers of the Pickwick Club.[4] Dickens described the clinical features and behavior of Joe, which became the model for many subsequent descriptions of these patients. In1918, William Osler, a 20th century physician coined the term pickwickian syndrome in reference to a character in Charles Dickens's novel The Pickwick Papers. The character named Joe has all the classic symptoms of the condition. Joe is constantly hungry, red faced and always falling asleep in the middle of doing a task.[5]

Obstructive sleep apnea syndrome (OSAS) is characterized by repeated episodes of upper airway obstruction during sleep, associated with increasing respiratory efforts, intermittent arterial oxygen desaturation, systemic and pulmonary arterial blood pressure surges and sleep disruption. The main symptoms of OSAS are nocturnal respiratory pauses interrupted by loud intermittent snoring and excessive daytime somnolence.[6] Obstructive sleep apnea/hypopnea syndrome (OSAHS) is known to be a frequent clinicalcondition inthe general population.[7]Obstructive sleep apnea occurs in 2-4% of adult population between the ages 30-60 years[8]thoughevidence suggests that many more patients remainundiagnosed.

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 day time fatigue and greater risk of automobile accidents.[9,10] Untreated OSA is associated with poor work [illegible]s.[11]

Corresponding Author:- Bobby Joseph Babu.

Etiology and Pathogenesis:

OSA is characterized by a collapsing of the tongue back on 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 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 co-factor because of its depressant influence on upper airway muscles and on arousal response that terminates each apnea.[12]

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 adeno-tonsillar 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.[12]

Frequently, sleep apnea patients have constricted upper airways that increase the pharyngeal resistance during inspiration. This, in turn, necessitates an increase in pharyngeal dilator muscle contraction to maintain airway patency. Such an increase has been shown in OSAHS patients during wakefulness,[13] but was also shown to decrease in contraction during sleep, thus contributing to the development of obstructive apnea.[14] Interestingly, when compared with normals, OSAHS patients show greater pharyngeal dilator muscle contraction during sleep, suggesting that an imbalance between negative airway pressure and dilator muscle contraction is responsible for the obstruction, rather than a primary deficiency in muscle contraction.[15] A sustained increase in dilator muscle contraction in OSAHS could predispose these muscles to fatigue,[16] possibly aggravating the tendency to pharyngeal occlusion.[15]

A clear understanding of the pathophysiology of the disorder is essential in implementing the optimal treatment, as well as developing future therapeutic modalities. The current treatment approaches have been based, to a large extent, on the principle of counteracting the factors that contribute to OSAHS pathophysiology.

Clinical Features and Risk Factors:-

The nocturnal signs and symptoms include drooling, xerostomia, sleep restlessness, witnessed apnea, choking or gasping and diaphoresis. The day time signs and symptoms include excessive sleepiness, xerostomia, morning headaches, non restorative sleep, gastroesophageal reflux disease, impaired concentration, depression, decreased libido, impotence and irritability.[11]

The primary risk factors for sleep apnea include:-

- ✧ Weight gain or being overweight with a BMI (Body Mass Index) >30 Kg/m^2
- ✧ Neck circumference [17in (or 43.2 cm) in men; 16in or (40.6 cm) in women]
- ✧ Age >40
- ✧ Male gender
- ✧ Structural factors related to craniofacial anatomy
- ✧ Ethnicity
- ✧ Family history of sleep apnea.[17,18]

Consequences of OSA:-

The cardiovascular consequences of obstructive sleep apnea can be acute and chronic.[17,19] In cross-sectional studies, the combination of acute and chronic haemodynamic effects in obstructive sleep apnea have been associated with increased risk of myocardial infarction, cerebrovascular accidents, and congestive heart failure.[20] OSAS may also be involved in the pathogenesis of nocturnal sudden death. In 1991, SEPPALA et al.[21] reported that increasing snoring severity was associated with increased risk for nocturnal sudden death, but the data were only indicative of a possible association of OSAS and nocturnal events since they were not based on polysomnographic recordings. In patients with polysomnographic diagnosis of OSAS, GAMI et al.[22] found that the risk of nocturnal (between 00:00–06:00 hrs) sudden death increased with OSAS severity, whereas cardiovascular events mostly occurred between 06:00–12:00 hrs in patients with no sleep apnea or subjects from the general population.

There is strong evidence that OSAS is an independent risk factor for systemic hypertension.[23-26] Careful case–control studies have confirmed the association of sleep apnea and increased blood pressure independent of confounders such as obesity.[27]A pathogenetic involvement ofOSAS in cerebrovascular disease is suggested by the directrelationship found between the severity of nocturnal oxygendesaturation and intima-media thickness and/or the occurrenceof atherosclerotic plaques in the carotid arteries of OSASpatients, independent of occurrence of hypertension.[28,29]

The relationship between OSAS and heart failure (HF) is complex. On the one hand, obstructive sleep apneas negatively affect cardiac function acutely and may cause cardiac remodelling in the long term, thus possibly contributing to the pathogenesis of HF. On the other hand, HF could contribute to the pathogenesis of SDB in the form of either obstructive or central apneas.[30-34]

Since the earliest clinical observations, OSAS has been recognized as a potential cause of arrhythmias during sleep.[10,23,35-37] Bradyarrhythmic episodes occur in OSAS patients, possibly reflecting reflex parasympathetic activity evoked by apneas; GUILLEMINAULT et al.[38] reported bradyarrhythmias in 18% of OSAS patients and BECKER et al[36] reported heart block episodes in 20% of patients with OSAS, especially when OSAS was severe. A pathogenetic role of OSAS is further suggested by the four-fold increase in the prevalence of atrial fibrillation in subjects with an AHI (Apnea Hypopnea Index) > 30 reported by the Sleep Heart Health Study Investigators.[39] The clinical relevance of the role of OSAS in atrial fibrillation is indicated by the high rate of recurrence of atrial fibrillation in inadequately treated OSAS patients.[40]

Several review papers have recently been published on the relationship between OSAS and the metabolic syndrome,[41-47] with special regard to the pathogenesis of increased cardiovascular risk. Increasing evidence indicates that OSAS and intermittent hypoxia may independently affect energy metabolism. IP et al.[48] reported that markers of OSAS severity (AHI and minimum oxygen saturation) were associated with insulin resistance, whilst PUNJABI et al.[49] reported that, in mildly obese but otherwise healthy males from the general population, SDB was associated with insulin resistance. Cross-sectional data from the Sleep Heart Health Study and the Wisconsin Sleep Cohort found similar results in population cohorts.[50,51]

The association of OSAS and type-2 diabetes was reported much earlier than the studies on insulin resistance, but the evidence was limited to small case series or epidemiological studies using snoring as a surrogate marker for

OSAS.[52] More recent epidemiological studies have convincingly shown that type-2 diabetes is often associated with OSAS and daytime sleepiness.[47-50,53-55] Sleep apneas are also frequent in children with type-1 diabetes[56] and adult patients with diabetic neuropathy,[57,58] but this probably reflects the consequence of abnormalities of ventilatory control associated with diabetes rather than a direct effect of obstructive apneas.[59-61]

Altered lipid metabolism and hepatic steatosis in OSAS have been recently studied.[34] As for the prevalence of hepatic steatosis in OSAS patients, insulin resistance and nonalcoholic steatohepatitis (NASH) often occur in obese and diabetic subjects,[62] and OSAS might contribute to NASH pathogenesis similar to its role in insulin resistance. According to SINGH et al.,[63] the prevalence of OSAS was, 50% in patients with nonalcoholic fatty liver disease, while severe OSAS represented a risk factor for increased liver enzymes and steatohepatitis independent of body weight.[64]

Diagnosis:-

The diagnosis of obstructive sleep disorder is based on a thorough history, a physical examination, and appropriate ancillary studies. Snoring is a cardinal finding. Nocturnal enuresis is also a common complaint that occurs because of a decrease in neuromuscular tone during sleep and may be worsened by an obstructive sleep disorder. Other nighttime complaints include night terrors, restless sleep, diaphoreses, and frequent awakening. Mouth breathing and hyponasal speech quality due to adenoid hypertrophy is also a frequent finding. Articulation errors are common with phonemes such as /m/, /n/, and /ng/.[65]

The examination should include a complete head and neck examination with particular attention to the potential sites for airway obstruction from the nares to the larynx. A complete nasal examination should be performed to rule out deviated septum, allergic rhinitis, choanal atresia or stenosis, and nasal masses such as dermoid, glioma, and encephalocele. The mandible should be assessed with regard to micrognathia or retrognathia.[65]

There is some controversy with regard to the accurate diagnosis of obstructive sleep disorder based solely on history and physical examination. Brouillette and colleagues have suggested that the diagnosis of obstructive sleep disorder can be based on a thorough history and examination. Other investigators have concluded that parents and physicians may overestimate the severity of the sleep disturbances and have recommended other ancillary testing to confirm the diagnosis.[66]

Soft tissue lateral x-ray films are most commonly used to assess adenoid hypertrophy. However, it is important to realize that these are two- dimensional studies and their accuracy in assessing the degree of nasal obstruction because of adenoid hypertrophy is controversial.[65] Common clinical and radiographic characteristics include mandibular retrognathia, retruded maxilla, posterior vertical maxillary deficiency, retropositioned tongue, high mandibular plane angulation, short chin-neck line, decreased PAS (Pharyngeal Airway Space) on lateral cephalogram, poor definition of gonial angles, and, often, Class II dental occlusion (but sometimes Class I).[67]

Some other characteristics that may be seen in these patients are nasal airway obstruction (ie, narrow nostrils, wide columella, enlarged turbinates, deviated septum, polyps, nasopharyngeal adenoid tissue, decreased posterior choanal height, etc) and oropharyngeal abnormalities (elongated soft palate, medially and posteriorly positioned posterior faucial pillars, enlarged adenoids, hyperplastic tonsils, macroglossia, etc).[67]

The following demographic and cephalometric characteristics are most likely to be expected in patients with severe OSA :

- Increased obesity and neck size
- A forward and extended head posture
- Increased soft palate and tongue dimensions
- A small naso-pharyngeal cross-sectional area
- Decreased sagittal upper-airway dimensions especially at the velopharyngeal level
- A lower hyoid position
- A smaller and retrognathic mandible together with an overall reduction in sagittal craniofacial dimensions.[67]

Apneic children have also been found to have longer H-MP (vertical position of hyoid to mandibular plane) distance. A descending position of the hyoid with increasing age is thought to be caused by the tongue's increasing in bulk and becoming larger in relation to the intermaxillary space, a trend that is pronounced in males. In adults,

craniofacial variables such as smaller PAS and increased soft palate length are thought to be associated with snoring and with the severity of sleep apnea.[68]

Polysomnography or sleep study is the gold standard for the diagnosis of sleep apnea or any other associated sleep disorder. The sleep study can determine frequency, type, duration, and severity of apneic episodes.[69,70] It provides information on several variables, which include oxygen saturation monitoring, electrocardiogram, electroencephalogram, electro-oculographic, electro-myographic, leg movement recordings, thoracic respiratory movements, and nasal and oral airflow. By monitoring these variables, one can differentiate between central and obstructive apnea.[65]

The only alternative at present is a procedure called overnight oximetry, which measures a patient's oxygen saturations throughout the night. Because severe apnea is often associated with significant arterial desaturation, it may be possible to use simple and inexpensive pulse oximetry as a screening method for the most severe disease. Overall, home evaluation is useful when the results are clearly positive. However, negative results do not rule out the presence of a sleep disorder.[19]

The current systems vary substantially from two-channel (snoring and oximetry) to four-channel (oximetry, airflow, effort, position), to full polysomnogram. Using 10 desaturations per hour as the cut-off, it has a 98% sensitivity but only a 48% specificity with a positive predictive value of 61% and a negative predictive value of 97% in those with a history suggestive of sleep apnea. It is not valid in those receiving oxygen therapy, however can be used to screen before ordering a sleep study, since it has a high negative predictive value and is inexpensive.[19]

The multiple sleep latency test (MSLT) is used in the assessment and diagnosis of disorders of excessive somnolence and to evaluate daytime sleepiness in relation to various therapeutic or experimental manipulations, such as administering drugs and altering the length or timing of nocturnal sleep. The MSLT measures the speed of falling asleep. A multiple sleep latency test may also be performed to assess the level of daytime sleepiness. The average adult requires 10 or more minutes to fall asleep during the day. A mean sleep latency of less than 5 minutes is considered abnormal. The MSLT may be useful to measure the degree of excessive daytime sleepiness and to rule out other types of sleep disorders. MSLT consists of 4-5 naps of 20 minutes duration every 2 hours during the day. The latency to sleep onset for each nap is averaged to determine the daytime sleep latency. Normal daytime sleep latency is greater than 10-15 minutes. OSA is generally associated with latencies less than 10 minutes.[67]

The technique of sleep nasendoscopy (SNE) was developed by Croft and Pringle (1991). The aim was to distinguish those patients presenting to a sleep disorders clinic who would benefit from surgical management of their condition from those who would not. The subjects were pharmacologically induced into a light phase of sleep, and the upper airway visualized directly, using a flexible, fibre-optic endoscope. Levels of partial or complete obstruction were noted and a grading scheme developed. Obstruction was designated as palatal, multi-level or tongue based (Pringle and Croft, 1993). The validity of SNE has been demonstrated by a number of researchers (Croft and Pringle, 1991; Camilleri et al., 1995; Sadoaka et al., 1996; Myatt and Beckenham, 2000) and its use as a pre-operative assessment has been shown to improve outcomes for palatal surgery.[72]

Accelerated airway inflammation may play a crucial role in the pathophysiology of obstructive sleep apnea (OSA); however this phenomenon has been investigated only in a limited number of studies. The analysis of exhaled breath represents a promising, non—invasive tool to evaluate airway inflammation in this context.[73] Nitric oxide is the most validated biomarker in exhaled air and its measurement has become of increasing interest over the last couple of decades. Fractional exhaled NO (FENO) is now used as a validated biomarker in the clinical setting of obstructive airway diseases, especially in asthma.[74] In general, FENO values tend to be higher in individuals with OSA than in healthy individuals.[73]

Differential Diagnosis:-

Other disorders also lead to daytime somnolence and, in the presence of snoring, can lead to referral for investigation of possible OSA. These include:

- poor sleep hygiene (inadequate length of sleep, irregular bedtimes, shift work, excessive caffeine ingestion, excessive bedtime stimuli such as a TV or computer)
- depression (early morning wakenings)

- periodic leg movements during sleep, which is part of restless legs syndrome and causes recurrent leg and arm movements and arousals from sleep
- less commonly, narcolepsy, caused by damage of the hypocretin/orexin pathways in the brain, probably from a viral infection in genetically susceptible individuals (HLA type DQB1*0602).[75]

Evaluation:-

Individuals with OSA are rarely aware of their sleep disorder, even upon arousal. Sleep apnea is usually recognized as a problem by family members who witness the apneic episodes or by a primary care doctor because of the individual's risk factors and symptoms. Most commonly, patients present with vague complaints. Clinical symptoms can include excessive daytime sleepiness (EDS) that usually begins during quiet activities (eg: reading, watching television), daytime fatigue, feeling tired despite a full night's sleep, morning headaches, personality and mood changes, dry or sore throat, gastroesophageal reflux, and sexual dysfunction.[17]

The Epworth sleepiness scale (ESS) has been universally adopted as an effective screening method to monitor for clinical symptoms of sleep apnea. This questionnaire is used to help determine how frequently the patient is likely to doze off in 8 frequently encountered situations (e.g., as a passenger in a car, sitting quietly after lunch, etc).[17]

Another effective screening tool that has been used in the primary care population is the Berlin questionnaire.[76] Survey questions address snoring behavior, EDS/fatigue, and history of obesity or hypertension. The sensitivity of the Berlin questionnaire with regards to high-risk patients having sleep apnea was 86%.[17]
Another screening tool called the STOP BANG questionnaire was developed to screen for the most common risk factors seen specifically in OSA. The term refers to a mnemonic that represents 8 factors: Snoring, Tiredness, Observed apneas, elevated blood Pressure, BMI (greater than 35 kg/m^2), Age (greater than 50), Neck circumference (greater than 40 cm), and Gender (male). Patients receive a point for each positive risk factor, and those whose scores are equal to or greater than 3 have a higher likelihood of having OSA. The sensitivities of the STOP BANG questionnaire for mild, moderate, and severe sleep apnea were 83.6%, 92.9%, and 100%, respectively.[17]

Individuals should have a routine evaluation of their upper airway. The Mallampati score has been used for years to identify patients at risk for difficult tracheal intubation. It is now also used commonly by sleep physicians to evaluate for risk of OSA. The classification provides a score of 1 through 4 based on the anatomic appearance of the airway seen when an individual opens his mouth. Studies have shown that for each 1 score increase in the Mallampati score, the number of apneic events increase.[77]

The AHI is an index used to assess the severity of sleep apnea based on the total number of apneas and hypopneas occurring per hour of sleep. In general, an individual is considered to have an OSA syndrome if they demonstrate an AHI of at least 5 with the presence of daytime symptoms or AHI of 15 or more independent of symptoms.[78] Respiratory Disturbance Index (RDI) like the AHI, measures respiratory events; however, it also includes respiratory event related arousals (RERAs). RERAs are arousals from sleep that do not technically meet the definitions of apneas or hypopneas, but do disrupt sleep. Some research studies have found that 30% of symptomatic patients would have been left untreated if the AHI were used rather the RDI.[79]

Conclusion:-

Obstructive sleep apnea is a disorder that has significant medical and psychosocial consequences. Although recognized for centuries, its importance for individuals and society has only recently been appreciated. In the context of the current epidemic of obesity, the prevalence and consequences of OSA is likely to increase in the coming years. Given the aging population, the number of neurological patients with OSA and comorbid stroke, epilepsy, headache, and cognitive decline is also likely to rise.

Fortunately, screening methods for sleep apnea have improved, and there are now very effective means of diagnosis and treatment. Because individuals with narrow airways and/or craniofacial anomalies may have increased risk for obstructive sleep apnea/hypopnea syndrome, dentistry can play a pivotal role in the identification and possible treatment of patients with this syndrome. Treatment can lead to a beneficial impact on a patient's health and quality of life. Several treatment options exist, and research into additional options continues.The medical community faces many hurdles regarding the development of adequate early screening and appropriate treatment of OSA.

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