Diagnostic and treatment workflow of the otorhinolaryngologists and dentists in patients suffering from the Syndrome of Obstructive sleep apnea and snoring

Milkov M.[1,2], Stoykov M.[1,2], Georgieva G.[1,2], Baycheva S.[3], Terzieva Z.[4]

[1]*Department of dental materials science and Prosthetic dental medicine, Faculty of Dental medicine, Medical University "Prof. Dr. Paraskev Stoyanov" – Varna, Bulgaria*
[2]*University medical and dental center, Medical University "Prof. Dr. Paraskev Stoyanov" – Varna, Bulgaria*
[3]*Faculty of Dental medicine, Medical University "Prof. Dr. Paraskev Stoyanov" – Varna, Bulgaria*
[4]*Medical University "Prof. Dr. Paraskev Stoyanov" – Varna, Bulgaria*

Abstract

Introduction. Obstructive sleep apnea and snoring syndrome is among the most commonly diagnosed sleep disorders. Physicians in dental medicine can play a valuable role in the multidisciplinary team of specialists, working to alleviate and treat the symptoms of patients, suffering from OSA and snoring syndrome. Dentists are often the worst to diagnose a symptom, typical for OSA.

Materials and Methods. For the literature overview and discussion on the topic of obstructive sleep apnea and snoring syndrome authors made a detailed literature overview, using the following keywords: obstructive sleep apnea, otorhinolaryngology, dental medicine, risk factors and time interval 2000-2023. Scientific databases PUBMED, MEDLINE, ScienceDirect and others were used. Information was taken from national scientific databases and monographic books on the topic. 545 professional drivers (mean age of 49.9 ± 8.8 years) were studied over a period of 7 years. All participants in the clinical study signed written informed consent forms and filled in written questionnaires. Criteria for inclusion of patients to the following study were: symptoms for the presence of the syndrome of sleep apnea and snoring, patients of at least 18 years of age, patients in the risk groups. All patients were tested with Weinmann® Somnocheck micro cardio. Ethical approval for the conduct of the study has been obtained by Medical University - Varna Ethic committee. Statistical analysis has been done with SPSS 18.

Results. Male gender was prevailing in the studied group of patients. 42.4% of the examined participants in the study presented with BMI above 30 kg/m2. The highest relative proportion of individuals was between 45 and 60 years of age. Special attention should be placed at the subjective criteria ESS score>10 and interview findings. No connection between sex, BMI and ESS-results has been proven. A connection between ESS and snoring has been proven. Professional drivers who snore express higher levels of excessive daytime sleepiness and daily fatigue. The more frequent nocturnal symptoms with a wider presence in the clinical picture of patients with OSA and snoring syndrome were snoring and apneic episodes.

Discussion. The OSA phenomenon appears due to the specific anatomy of the upper respiratory tract. As obstructions appear in the oral and nasal cavity, it is normal to approach the primary examination by an ear, nose and throat doctor and a dental practitioner. The actions taken by clinicians in these two specialties, in collaboration with colleagues from other subspecialties, are decisive for the course of the treatment. The dental practitioner can screen for patients at risk for a sleep disorder and, when properly trained, to treat those individuals, using intraoral dental appliances.

Conclusions. Specialists in otorhinolaryngology, head and neck surgery and physicians in dental medicine should work more and in better collaboration when examining and prescribing treatment of OSA patients in our country. Organizing scientific events and symposia, accompanied by practical courses, significantly helps specialists to improve their knowledge and diagnostic skills in the field. Dental professionalists can often be the first to encounter a patient with hidden and non-diagnosed sleep apnea. More efforts should be invested in educating dental professionals, students and residents in OSA symptoms and screening.

Introduction

Obstructive sleep apnea and snoring syndrome (OSAS syndrome), along with insomnia, is among the most commonly diagnosed sleep disorders. But unlike insomnia, sleep apnea is a medical condition, little known to the general population.

Prevalence of the OSAS syndrome varies between 4-6% for male and 2-4% for female individuals. Incidence increases significantly with age. [1] One of the common problems, encountered by specialists in OSAS diagnosis, is the difficult accessibility to do research for the condition. Authors in clinical trials are continuously looking for alternatives to the expensive polysom-

nography (PSG) studies that are currently the standard diagnostic test [2].

Unfortunately, sleep apnea is often neglected, hidden and ignored by patients. Underdiagnosis appears to be one the main problems that need to be resolved [3]. Recent studies have shown that only 6% of the anamnestic data at the initial examination point refers to a possible sleep disorder [4]. Underdiagnosis can lead to fatal consequences for patients, who are not acquainted with the possible ways to cope with the everyday symptoms [3]. Obstructive sleep apnea is one of the often-neglected medical conditions in Bulgaria. Physicians in dental medicine play a valuable role in the multidisciplinary team of specialists, working to alleviate and treat the symptoms of patients, suffering from OSAS syndrome. Dentists are often the first to diagnose a symptom, typical for OSAS - xerostomia, redness of the soft palate, enlarged tongue, dental caries and others [3].

Due to the multifactorial pathophysiological mechanisms, the diagnosis of OSAS can be misleading and be understood simply as a diagnosis of OSAS can be misleading and be understood simply as a state of a chronic fatigue rather than a serious disease with its potential consequences. It is necessary to establish a differential diagnosis between other diseases, manifesting with similar symptoms, such as snoring or hypersomnia [3].

The first to recognize the importance of OSA were health authorities in the United States of America. In 1988, the US Congress established the National Commission on Sleep Disorders to conduct scientific research on sleep disorders. The goal was to develop a plan to combat sleep disorders and to better study them. Results showed that each year the lives of millions of Americans were greatly affected by different sleep disorders [5]. The increased interest in the diagnosis made a number of scientists and their teams begin the conduction of epidemiological studies.

The great risk of falling asleep behind the wheel or while working with sophisticated machines can result in the loss of a large number of human lives and pay the huge price of ignorance. Lack of good awareness about the mechanisms behind the manifesting symptoms of the disease is another problem. Conferences, congresses, literature and the Internet regularly acquaint specialists in the field with the latest scientific achievements.

OSA can be a potential diagnosis when a male, middle-aged, overweight, short-necked patient with signs for arterial hypertension comes to the office for a medical check-up and consultation. These patients appear tired, complaining of daytime sleepiness and reduced quality of life. Loud snoring and breathing cessations at night are what the partner hears and for which the patient seeks help. The patient usually shares about breathing through the mouth and a feeling of a restless sleep [3].

Even with the emergence of the concept related to the symptoms of apnea in 1973, with the publication of Guilleminault [6] it was clear that the newly discovered syndrome will be highly debated by scientists due to the variety of additional symptoms that appear and the extensive impact on a number of anatomical systems in the human organism. OSA is currently considered a clinical disease and a differential diagnosis should be made with other diseases associated with sleep-disordered breathing. The syndrome of increased upper airway resistance was highly debated. Awakenings, interrupted sleep, inability to fall into and maintain quality sleep, increased daytime sleepiness were found. Scientists consider this syndrome as a significant disturbance of breathing during sleep, while according to other authors, the syndrome is a minor manifestation of OSA [7].

The prevalence of snoring and OSA depends on age and gender. There are significant differences in terms of genetic and ethnic factors. Information on the frequency of snoring varies between 20 and 46%, according to studies [3]. The fact that there is neither a reliable definition nor an objective diagnosis for snoring explains the range of variation.

In 1993, the New England Journal of Medicine published the first study (Young et al.) on the prevalence of OSA [8]. It included a random sample of 602 people (men and women), aged

between 30 and 60 years. The importance of the mentioned study was particular due to the fact that, for the first time, authors referred to a large group of people, regardless of gender, covering different age groups. Study's findings [8] pointed to male gender and obesity as strongly associated with the development of OSA. Snorers more often developed AHI values of 15 and above and respiratory disturbance index (RDI) values sufficient to make a diagnosis.

Although no recent epidemiological studies have been conducted on the syndrome of OSA and snoring, Spanish authors [9] concluded that 2-4% of the population meets the criteria for this diagnosis. In patients older than 65 years, this percentage jumps to 25. Another extensive scientific study in Spain, published in 2001 in the American Journal of Respiratory and Critical Care Medicine [1], showed similar results [9]. The mentioned study by Duran and colleagues reported the prevalence of OSA among a group of people between the ages of 30 and 70, taking into account factors such as comorbidities, including breathing problems induced by hypertension. The results showed the presence of snoring in 35% of patients, and cessations in breathing were observed in 6%. Both signs were more common in men, increased in frequency with age, and were strongly associated with OSA. Daytime sleepiness was observed in 18% of the study participants, with no clear association with OSA syndrome and snoring. An AHI index >10 was observed in 19% of men and 15% of women. The prevalence of OSA (AHI>5) increased in both sexes with the advancement of age. The index was clearly associated with hypertension when age, sex, body mass index, neck circumference, alcohol consumption and smoking were taken into account. This study demonstrated the relationship between OSA and arterial hypertension.

Most of the data published in the literature point to potential differences in the structures and sizes of the upper airways between patients with OSA and healthy or snoring patients. The upper airway is narrower in patients with sleep apnea compared to healthy individuals, particularly in the retropalatal region. Retropalatal tissues have been reported as larger in OSA patients versus controls.

A high apnea-hypopnea index appears to be associated with large volumes of the tongue and soft palate, and a significant correlation has been documented between the retropalatal space, its lateral diameter and the respiratory distress index. The combination of the smallest cross-sectional area, upper airway resistance and body mass index (BMI) was used to predict the severity of the condition. A narrower upper airway cross-section and a thicker soft palate were found in severely affected patients versus patients suffering from mild to moderate case of obstructive sleep apnea [3], [10,11].

Snoring is among the most common symptoms of the clinical presentation of OSAS. As it is believed, "this is the tip of the iceberg". Snoring is a "valuable symptom" - it brings the patient to the clinic and can save lives. There are cases diagnosed only with the clinical picture of snoring in patients with an adequate body mass index and no general diseases. The fact that a person snores does not necessarily mean that OSA has developed. Snoring in patients with sleep apnea differs from the ordinary incidental snoring in healthy individuals [10].

The term apnea was introduced by Guilleminault and Dement [7], defining it as a complete cessation of airflow for 10 or more seconds. It can be of an obstructive type if it is accompanied by respiratory efforts, or of a central type, in which no thoracoabdominal efforts are observed. There is a third, neurological or mixed type, combining a central component at the beginning and an obstruction at the end. The number of apneic episodes at night, determined by the AHI index, provided valuable information for the prognosis of OSA. Partners of a sleep apnea sufferer described episodes of apnea as disturbing pauses that end with a noisy, unconscious awakening. This is one of the most straightforward signs by which to judge for the presence of obstructive sleep apnea.

The term hypopnea was coined by Kart and colleagues who refer to a partial reduction in airflow that causes oxygen desaturation and awakenings. Authors around the world often debate on what definition to adopt, as there are no standardized

criteria. The American Academy of Sleep Medicine defines hypopnea as a detectable decrease in the respiratory signal together with a decreased oxygen saturation of at least 3% and/or electroencephalographically proven awakenings [10]. In general, and according to the recommendations of the Spanish Society of Respiratory Diseases, a state of hypopnea is considered to be demonstrated when the respiratory signal is reduced by more than 30% (but less than 90%) in combination with transient awakenings and/or oxygen desaturation less than 3%.

Arousal is a word of Anglo-Saxon origin and means awakening. This is a characteristic event for OSA. The body "jumps" from a state of sleep to a state of wakefulness in response to a sudden phenomenon. In apneic episodes, awakening is a response to a cessation of breathing. These transient awakenings return the patient to the physiological state of wakefulness in which phasic upper airways' activity returns. [10,11].

The term Respiratory effort-related arousal (RERA) refers to periods of at least 10 seconds, indicating a progressive increase in the respiratory effort. This is ideally accounted for by monitoring pharyngeal pressure. The episode ends with an arousal (awakening). The presence of such efforts distinguishes the three main types of apnea (obstructive, central and mixed).

Excessive daytime sleepiness is an important symptom in the diagnosis of OSA. It is defined as a tendency to fall asleep involuntarily during the day, either at work, while driving or in other monotonous situations. In most cases, insufficient quality and quantity of sleep is the cause. Poor sleep hygiene can lead to hypersomnia.

The total number of apneas and hypopneas per hour of sleep is defined as the apnea-hypopnea index. An index value of less than 5 is considered normal, but is not sufficient to rule out the presence of sleep apnea with certainty. Values up to 20 indicate a mild case of OSA, and between 20 and 40 indicate moderate severity. Severe OSA is established with an AHI index of values greater than 40. According to other authors, values up to 15 are considered a mild form of sleep apnea, between 15 and 30 for moderate severity and over 30 for a severe form of OSA. Other parameters are thought to contribute to the severity of the disturbance, including oxygen desaturation, cardiac arrhythmias, comorbidities, and clinical symptoms such as daytime sleepiness and cognitive function [12, 13].

Materials & Methods

Authors show their experience in diagnosing and treating patients with obstructive sleep apnea and snoring syndrome in the time period 2016-2023 (which continues at the moment), while working in multidisciplinary teams of medical specialists. Realizing the need for an early detection of OSA in certain high-risk professional groups (professional bus and taxi drivers, pilots, maritime officers), on the initiative of the Bulgarian Academy of Sleep Medicine (BASM) and with the assistance of the academic management of Medical University – Varna, Faculty of Dental medicine and University medical and dental center, authors aimed at, conducted and are still managing "Screening for obstructive sleep apnea in professional drivers" study. It is now enlarged and includes patients from groups at risk, such as professional bus and taxi drivers, marine officers, aircraft pilots.

For the literature overview and discussion on the topic of obstructive sleep apnea and snoring syndrome authors made a detailed literature overview, using the following keywords: obstructive sleep apnea, otorhinolaryngology, dental medicine, risk factors and time interval 2000-2023. Scientific databases PUBMED, MEDLINE, ScienceDirect and others were used. Information was taken from national scientific databases and monographic books on the topic as well. Data from fundamental studies in the scientific area of sleep apnea was added. Authors aimed to include clinical studies with detailed information for the prevalence of OSA and its consequences among patients included.

Authors present their work in examining patients and organizing scientific events, popularizing the need for better diagnosing and treatment of the obstructive sleep apnea and snoring syndrome among clinicians, general practitioners and soci-

ety. 545 professional drivers with a mean age of 49.9 ± 8.8 years (range 19–71 years) were studied over a period of 7 years on the premises of the University medical and dental center, Faculty of Dental medicine, Medical University "Prof. Dr. Paraskev Stoyanov" - Varna, Bulgaria. All participants in the clinical study signed written informed consent forms and filled in written questionnaires – Berlin questionnaire, Epworth Sleepiness scale questionnaire (ESS), especially developed by team, assessing general symptoms, comorbidity, medications intake.

Authors started the examination of a patient with suspected OSA and snoring by taking a detailed medical history anamnesis. Detailed information was collected about past and present illnesses. Attention was paid to family history and genetic burden. These are the "pillars" on which the specialist in sleep medicine relies in order to make the correct diagnosis, taking into account diseases in the differential-diagnostic aspect.

Criteria for inclusion of patients to the following study were: symptoms for the presence of the syndrome of sleep apnea and snoring (gathered by filling in sleep questionnaires-Berlin Questionnaire, Epworth Sleepiness scale questionnaire and by testing the sleep with HSAT), patients of at least 18 years of age, patients in the risk groups (professional drivers, pilots, maritime officers). Criteria for exclusion were: patients not filled in the questionnaires and who did not have their sleep tested with HSAT, with no symptoms for OSA and snoring, patients who were less than 18 years of age, patients outside the risk groups.

When interviewing the patient, some of the questions were asked to the partner as well, as often the patient did not suspect the appearance of some night symptoms of the disease. It was important to collect information about what the patient did in order to assess the hazards that the disease may pose while performing normal work duties. Shift work, altered sleep patterns, and excessive sleepiness contribute to the disorders. Family burden and genetic predispositions are extremely important in patients with OSA. Authors screened the patients for the mentioned possibility. All patients were tested with Weinmann® Somnocheck micro cardio (Home Sleep apnea test, HSAT), after careful anamnesis taking, general otorhinolaryngological and dental check-up. The reports, generated by the software of the device, utilizing apnea-hypopnea index (AHI) and respiratory disturbance index (RDI), classified the case of OSA into mild, moderate and severe. Before the polygraphic examination, based on the results from Berlin and ESS questionnaires, patients were classified at low, moderate or high risk for having developed OSA.

Ethical approval for the conduct of the study has been obtained by Medical University - Varna Ethic committee. (№ 99/14.01.2021) Statistical analysis has been done with SPSS 18. Tests used to analyze the information as follows: Independence of observations, Homogeneity of variance, Normality of data, Correlation tests, Chi square test of independence.

The main goals of the screening were not only the early detection of potential OSA patients, but also the creation of confidence in them that OSA is a serious, but treatable disease, that requires consistency and persistence in treatment process. Authors would like to stress on the outcomes of the mentioned study and to state the role of the physicians in dental medicine - often one of the first to spot the signs of OSA.

Results

Male gender was prevailing in the studied group of patients (male participants were 524,96.1%). 42.4% of the examined participants in the study presented with Body mass index (BMI) above 30 kg/m², which made their risk of developing OSA higher. The highest relative proportion of individuals was between 45 and 60 years of age (65,6%). In Table 1 authors present a summary of the diagnostic criteria implemented when examining professional drivers and other patients at risk (pilots, marine officers) to develop obstructive sleep apnea. (Modification by the team based on the summary of The American College of Chest Physicians, The American College of Occupational and Environmental Medicine, The National Sleep Foundation) (Table 1).

According to authors view and the results from the study, special attention should be placed at the subjective criteria ESS score >10 and interview findings, alongside with the objective criteria of BMI ≥30 kg/m² and neck circumference over 17 inch for males and 16 for females.

Table 1: A summary of the diagnostic criteria used for professional drivers and other groups of patients at risk to develop obstructive sleep apnea

Criteria to detect OSA	**Professional drivers and other patients at risk, for whom one or more criteria apply, are at risk for developing OSA**
Total screened n = 545, from whom: male = 524 (96.1%); female = 21 (3.9%) Mild OSA = 150 (27.52%), from whom: male = 142 (94.67%); female = 8 (5.33%) Moderate OSA = 300 (55.05%), from whom: male = 290 (96.67%); female = 10 (3.33%) Severe OSA = 95 (17.43%), from whom: male = 92 (96.84%); female = 3 (3.16%) Positive on ESS – from 545,500 (91.74%). Positive on Berlin questionnaire – from 545,540 (99.08%).	
Subjective criteria	
From the interview	One/Some of the following symptoms present: snoirng, excessive daytime sleepiness, apneas, memory deficiency; sexual problems; vestibular (balance) problems
	History for a motor vehicle accident (possible connection with a sleep disorder)
	A previous diagnosis of OSA; a polysomnographic/polygraphic test with an AHI result > 5; undergoing CPAP-treatment
Epworth sleepiness scale	ESS score > 10
Objective criteria	Falling asleep while waiting to be examined/while waiting at a traffic light; while reading a book/newspaper at home
	Two or more from the following: • BMI ≥30 kg/m² • Neck circumference – 17 inch (males), 16 inch (females) • Hypertonia (newly diagnosed, non-controlled, demanding more than 2 medications in order to be controlled)

On Fig. 1 the mean age of the participants is depicted.

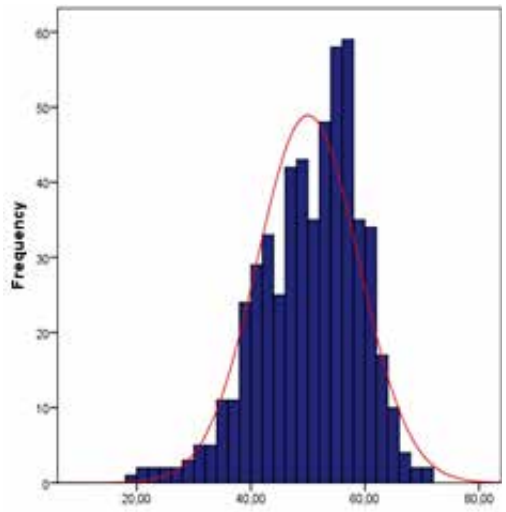

Figure 1: Mean age of the participants (professional drivers and patients at risk)

On Table 2 an assessment for the risk factors in our patient group for OSA is made. (Table 2) In column OR the chances for expressing the symptoms and having developed OSA is shown. No connection between sex, BMI and ESS-results has been proven. A connection between ESS and snoring has been proven. Professional drivers who snore express higher levels of excessive daytime sleepiness and daily fatigue.

Table 2: Symptoms and chances for having developed OSA/statistical significance

Symptom	OR	95%CI	P
Low quality sleep with frequent wakings	7.00	2.72-18.02	<0.001
Choking when sleeping	7.69	2.27-26.42	<0.001
Breathing cessation during sleep	10.59	2.44-46.12	<0.001
Excessive sweating during sleep	4.09	1.89-8.89	<0.001
Nocturia	2.23	1.16-4.28	0.014
Morning waking up when excessive tiredness	10.81	3.36-34.82	<0.001
Xerostomia	6.55	2.68-16.02	<0.001
Dozing off while reading/watching TV	3.21	1.47-6.95	0.002
Breathing insufficince during normal physical activities	3.29	1.37-7.88	0.005
Difficult breathing when sleeping at night	5.06	1.99-12.86	<0.001
Higher neck circumference	3.08	1.29-7.33	0.008
Diabetes mellitus	2.95	1.13-7.69	0.022
GERD	2.26	1.04-4.89	0.036
Sexual problems	4.79	1.81-12.70	0.001
Lowered work activity and concentration	6.09	1.47-25.35	0.005
Memory problems	3.42	1.09-10.72	0.026

According to the results shown in Table 3, the connection between the possibility for having developed OSA and low quality sleep with frequent wakings, choking when sleeping, breathing cessations during sleep, excessive sweating during sleep, morning waking ups with excessive tiredness, xerostomia, diffcult breathing when sleeping at night, authors prove to be of statistical significance. (p<0.001)

On Fig. 2 the connection between falling asleep while driving, according to the results from ESS, is shown. The connection between higher ESS and chances for falling asleep while driving are clearly visible, especially in patients with higher BMS and age.

Symptoms, found in patients examined, authors would like to put stress on. Symptoms were similar, but patients, included in the reported study,

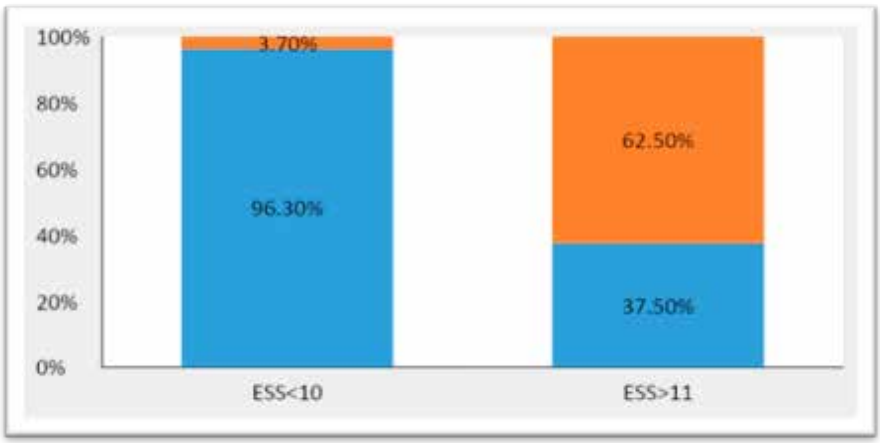

Figure 2: Falling asleep while driving – ESS results ESS-Epworth Sleepiness Scale; Blue-answer No; Orange - answer Yes

had a number of specific complaints. The symptomatic triad, typical of OSA – snoring, apnea, hypersomnolence, did not appear equally in all patients. Accurate diagnosis required conducting full examinations (including roentgenographic) to establish common and less common symptoms. The more frequent nocturnal symptoms with a wider presence in the clinical picture of patients with OSA and snoring syndrome were snoring and apneic episodes (apnea/hypopnea).

Sleep apnea often worried the partner for fear of suffocation or a fatal outcome. Usually, the partner took action to wake up, or he (she) himself (herself) begins to suffer from a sleep disturbance and moves to sleep in a separate room.

Discussion

The OSAS phenomenon appears due to the specific anatomy of the upper respiratory tract – a fact that has been emphasized several times so far. As obstructions appear in the oral and nasal cavity, it is normal to approach the primary examination by an ear, nose and throat doctor and a dental practitioner. The actions taken by clinicians in these two specialties, in collaboration with their colleagues, specialists in pulmonology, cardiology, endocrinology, are decisive for the course of the treatment [3].

The pharyngeal section of this airway functions as a collapsible segment which, during inspiration, can only be opened by the activity of the pharyngeal muscles. This principle explains why OSA can usually only be detected during sleep. With the onset of sleep, there is a decrease in muscle tone in the area of the dilatator muscles of the upper respiratory tract, depending on the depth of sleep. This alone, especially in REM sleep, can exceed the compensatory capacity of the upper airway muscles and cause airway obstruction. There have been numerous attempts to explain why OSA does not occur in all but only in some individuals. [1]

To counteract the negative pressure that occurs during inspiration, a reflex activation of the pharyngeal dilatator muscles occurs physiologically just before the start of inspiration. This reflex muscle activation is impaired in patients with obstructive sleep apnea. Decreased pharyngeal sensitivity has been demonstrated in patients with OSA. It is believed that the continuous vibrations of the upper airway soft tissues in the context of snoring and apneic phases lead to increased vibrational trauma in those affected. The reflex activation of the muscles during inhalation is limited and the collapsibility of the system is increased. [3]

Severely restricted nasal airflow can cause compensations that include an inferior position of the mandible at rest, increased vertical dimension of occlusion (VDO), a lower or more mesial position of the tongue, a hyoid bone in an inferior position, redirection of nasal-to-tongue, a hyoid bone in an inferior position, redirection of nasal-to-oral breathing, forward extension of the head and neck, increased anterior facial height, increased angles of the mandibular and occlusal planes, narrow base of the nose, narrow upper jaw, higher arch of the palate, posterior crossbite, class II occlusion, etc. These compilations of maxillofacial and occlusal features form a facial phenotype known in the orthodontic literature as facies adenoidea. The airway is widest when there is normal mandibular and maxillary growth and when the facial growth pattern is following to so-called “counterclockwise rotation”. Conversely, the airways are smaller when there is insufficient growth of the maxilla and the mandible and when there is a facial growth with the “clockwise rotation” [3].

Extensive literature is available comparing the anatomy of the upper respiratory tract and dentofacial structures. X-ray cephalometry is used to compare structures in OSA and healthy patients. The following findings in patients with OSA may be diagnosed: longer soft palates, reduced minimal palatal width, increased soft palate thickness, increased pharyngeal length, retroposition of the mandible or maxilla, micrognathia, increased medial height of the face and differences in the position of the hyoid bone. In general, the differences were more pronounced in non-obese patients, suggesting that craniofacial changes play a dominant role in this subgroup. In addition, the significant differences in the maxillofacial appearance of individual ethnic groups must be taken into account.

The dental practitioner can screen for patients at risk for a sleep disorder and, when properly trained, to treat those individuals, using intraoral dental appliances. The physician in dental medicine should determine whether the patient is at risk to develop a sleep disorder by using questionnaires and reviewing the medical history [14]. The role of the dental practitioner is rapidly expanding. The overall health of patients can be affected by the health of their oral cavity. This relationship is becoming increasingly recognized in the scientific literature as it relates to cardiovascular diseases in individuals with periodontitis. A direct relationship has been established that obliges dental practitioners to be more active in controlling the periodontal process for dental and medical reasons [3].

Studies show that dental practitioners, with knowledge in sleep disorders, are just as likely to recognize a patient with a sleep disorder as a general practitioner. Milder cases of obstructive sleep apnea may be treated by the dentist in consultation with a sleep medicine specialist [15,16].

The first step for the dental practitioner is to be competent in screening for sleep disorders. The screening can be done by adding basic and simple questions to an existing health survey, or the dental practice can use the Epworth Sleepiness Scale (ESS). This is a questionnaire commonly used in sleep medicine to assess a patient's risk of daytime sleepiness and other risk factors. Epworth Sleepiness Scale is a simple method in which the patient self-assesses the level of sleepiness during the day. Eight situations of the day and the chances of the patient falling asleep are set. Situations are rated with a number from 0 (least chance of falling asleep) to 3 (high chance of falling asleep). The total score ranges between 0 and 24, and all values above 10 indicate excessive daytime sleepiness. The test is subjective and is accepted as a screening test when accepting a new patient in a given clinical practice [3].

A more basic set of 4 questions, known by the acronym STOP, can easily be added to an existing survey. Positive answers to two or more of the questions represent an increased risk of sleep apnea. This questionnaire was later expanded into the STOP-BANG. The added four questions appear to be crucial in determining the risk of sleep apnea. A recent study found that using these questions was highly successful in predicting the risk of sleep apnea [17]. The study shows that a score of three or lower has a low probability of expecting sleep apnea. However, the probability increases if the result is between three and five. If the score is above five, then the patient is at greater risk of developing severe sleep apnea. In general, if a patient's score is zero to three, other risk factors should be considered.

Five basic questions can easily be added to the questions that dentists routinely ask during the interview that may help identify the presence of a sleep disorder [14]. Patient is asked whether or not he/she find a problem falling asleep or has a problem sleeping. Another question asked is whether patient snores and whether or not feels tired during the day. Clinician should ask if anyone has told the patient that he/she has stopped breathing during sleep and if he/she feels restless after sleep.

Positive answers to these questions would indicate the need for a further evaluation. At this stage, patients should complete the Epworth scale and STOP-BANG surveys. If there are positive answers, patients should be referred to their GP or sleep medicine specialist [3]. In addition to gathering information from the medical history, dental professionals using the Epworth or STOP-BANG scale questions should be aware of everyday clinical observations that may indicate the risk for sleep apnea developing. Without proper training or knowledge, the dental practitioner may not make the connection between these common occurrences and the risk of a possible breathing disorder during sleep [3], [14].

The best way for dental professionals to recognize these symptoms is to become familiar with the conditions they may encounter and what they may indicate. Physicians in dental medicine may detect other sleep disorders common in the practice, for example, patients who have orofacial pain or complaints of headaches may be at risk of insomnia. Dental practitioners often treat bruxism patients with various types of intraoral

appliances. The presence of bruxism may indicate an increased risk of restless legs syndrome or periodic limb movement syndrome [3], [14], [18].

The process of taking the patient's history and chief complaints will provide information about the patient's symptoms. It may include questions about common sleep disorder symptoms such as poor or restless sleep, daytime sleepiness or tiredness, snoring, noticeable apneas, teeth grinding (bruxism), headaches, gastroesophageal reflux disease (GERD), depression, poor concentration and lack of energy, mood swings or irritability. This assessment will summarize the findings of a sleep study, if one was performed prior to the patient's current visit, and may ask if Continuous positive airway pressure (CPAP) or was prescribed and what the patient's response was. When taking the anamnesis, patient's current state of health and whether he/she is taking medications are usually taken into consideration. At this stage, the possible health consequences of a sleep disturbance and more specifically sleep apnea may become apparent. Special attention should be paid to headaches, cardiovascular disease, diabetes, asthma, allergy, neurocognitive difficulties, and what medications are taken to treat them. Blood pressure should be measured, which is common for most dental practices [14].

When the dental practitioner is actively involved in the treatment of a patient with sleep apnea through an intraoral appliance, the need for a more detailed assessment is essential. This assessment will be in addition to the routine clinical data that may already be available.

The more detailed assessment is designed to assess a diverse array of factors in the oral cavity, head, neck, and airways. These areas may be of particular interest not only from a dental perspective, but also in relation to the oropharynx and nasal airway, which may affect the proposed use of an oral appliance.

The temporomandibular joints (TMJs) should be examined for clicking sounds, tenderness, or pain, and for any movement dysfunctions. The range of motion of the mandible has to be assessed. Many dental professionals do not have adequate training to evaluate these areas, although they need to be well-trained and qualified in this process. Any additional complaints of orofacial pain other than temporomandibular joint dysfunction should be considered [3], [14].

Muscle tenderness in the head and neck region is often a component of the temporomandibular joint dysfunction syndrome and may be associated with bruxism. Travel and Simmons [19] found that muscles have trigger points with the potential to refer pain to a distant area. Activation of these trigger points in the head and neck area may be associated with complaints of headache, sinus pain, facial pain, temporomandibular joint dysfunction, and otalgia. Dentists should assess the tenderness of patients' head and neck muscles because these muscles may become sore if intraoral appliances are used in the future. It is important to know in advance if there is a palpable muscle tenderness in order to anticipate possible myofascial pain associated with the use of the appliance. It is recommended to first measure the range of motion of the mandible, because palpation can irritate the muscles and thus limit its movement. Often the patient has mainly muscle or myofascial pain, which can be directed to the temporomandibular joint or the areas around it. Poor quality and quantity of sleep and TMJ dysfunction are known to often co-occur [20].

All dental professionals feel comfortable evaluating the teeth and supporting structures in the oral cavity. This part of the assessment is designed to assess conditions that may affect or be affected by the use of an oral appliance. A dental practitioner should evaluate for the presence of periodontitis, especially loose teeth. He/She should check for dental caries. If the patient is on medications, attention should be paid to dry mouth (xerostomia). Certain oral and dental findings may limit the success of an oral appliance. These may include large mandibular tori, a high palatal arch associated with a narrow maxilla or posterior crossbite, and teeth that are clinically short, which may negatively affect the secure attachment of the appliance. The position of the tongue in the mouth at rest relative to the soft palate and the ability to see the oropharynx should be assessed. This score is known as the

Mallampathi score and was revised by Freidman and Tanyeri [3], [14], [21]. One study showed that as Malampathi scores increase, the potential risk of obstructive sleep apnea and the likelihood of an increase in the apnea-hypopnea index rise [22, 23].

The lingual frenulum, which is located on the lower surface of the tongue, at the base of the mouth, should be examined. If the frenulum restricts tongue's mobility, it is more likely to be in a lower position and not resting on the palate as it should. The latter may cause the base of the tongue to be further back towards the oropharynx.

The posture of the head in the area of the cervical vertebrae is important to assess. Poor posture, especially when it comes to the head and neck, can be the cause of pain, headaches, temporomandibular joint dysfunction, and even disturbed sleep. At the same time, poor posture, especially in the head and neck area, can indicate an existing respiratory problem. During sleep, and even when a person is awake, a change in the posture of the head in the area of the cervical vertebrae can indicate the presence of a compromised airway or difficulty breathing [14]. Some patients have difficulty breathing through the nose, especially at night, which increases the likelihood that they will start breathing through the mouth. Addressing this issue becomes the key to the effectiveness of CPAP and may alter the levels of oxygen saturation during sleep [3], [24–25].

The initial evaluation of patients with sleep disorders can be extensive. If the concern is related to nocturnal manifestations such as snoring, irregular breathing, excessive movement, or unusual behavior, details provided by the patient, partner, or even audio-visual recordings are helpful. Additional details include the patient's daily routine, nighttime awakenings, how long it takes to fall back asleep, what time the patient wakes up in the morning, total sleep duration, and perceived sleep quality. Environmental factors including light, noise, temperature, bed comfort, use of electronic devices and pets are among the potential aggravating factors. Morning symptoms such as dry mouth, headache, jaw discomfort and level of alertness can help better identify a sleep problem. The daily regime, including afternoon naps, meal times, caffeine and alcohol use, and alertness levels are valuable as well. A review of previous illnesses, medications intake, social and family history, and a review of body systems should be done routinely [3], [14].

In comparison to the lateral X-ray cephalometry, CT-scanning methodology can significantly improve the contrast of the soft tissues in the upper airways, static and dynamic assessments, measuring the volume, 3D-reconstructions and to allow precise cross-sectional measurements at different levels [3].

Breathing sounds, body position, and unusual behavior or movements during sleep can be recorded using video and audio sleep monitoring devices in the patient's bedroom or through direct observations and documentation by a sleep medicine laboratory technician.

Body position is particularly important in the assessment of sleepdisordered breathing. Often, these disorders are more severe when sleeping on the back, possibly related to the position of the jaw and tongue and posterior displacement, resulting in more severe obstruction.

The approach authors used in proven OSA cases was to additionally monitor the patient and change acquired harmful sleep habits. Daytime sleepiness was difficult to measure as it is entirely subjective.

Polysomnography (PSG) is commonly used to objectively assess sleep and its different stages. It consists of continuous and simultaneous recording of several physiological indicators during sleep, ones of which are electroencephalography (EEG), electrooculography (EOG) and electromyography (EMG). Other devices can be used during polysomnographic recording, including an electrocardiograph, airflow and snoring sensors, chest and abdominal motion detectors, oximetry, and limb EMG to detect abnormal sleep-related breathing disorders, unusual limb movements or behavior [3], [14].

The study of Young et al. [8] reported that by means of nocturnal polysomnography, the AHI

index was calculated according to gender and age. It was concluded that the prevalence of OSA (AHI more than 5%) was 9% for women and 24% for men. Comparing the results to the general population, the authors reported that 2% of active women and 4% of active middle-aged men met the criteria for a diagnosis of sleep apnea syndrome.

Polysomnography is as well used by dental colleagues, but they more often use polygraph analysis. We introduced the polygraph analysis to the Faculty of Dental Medicine of Medical University "Prof. Dr. Paraskev Stoyanov" - Varna, Bulgaria, in 2010. For the first time in Bulgaria, the Apnea Graph method, implementing a special probe. A PhD-thesis on the topic of OSA and the dental appliances used for treating the mild cases has been defended in 2021, thanks to the joint efforts of a number of specialists from medical fields close to the sleep apnea disorder.

In 2012 in the town of Varna, Republic of Bulgaria, specialists and scientists from various specialties and universities created the "Bulgarian Society for Obstructive Sleep Apnea and Snoring". In 2014, the first international interdisciplinary symposium dedicated to sleep problems was held in Varna together with Medical University "Prof. Dr. Paraskev Stoyanov" – Varna and the World Association of Sleep Medicine [3].

In order to increase the awareness of the clinicians from various specialties related to OSA, as well as their interest in the research and treatment of these patients, in 2015 a training course on sleep dentistry was organized and conducted, in 2014 and 2016 – international symposia, and in 2018, 2020, 2021, 2022, 2023 – international conferences, with the participation of prominent specialists in the field of the obstructive sleep apnea.

A number of informational-prophylactic campaigns were organized where in a single campaign, no less than 100 patients in each of the campaigns were examined and diagnosed. Students and residents participated in the organization of the training courses, symposia and conferences, as well as in the conduct of the screening [3]. Colleagues and members of BASM actively participated in the preparation of these events. Optional elective course "Obstructive sleep apnea and snoring. Diagnosis. Treatment. Prevention" for "Dental Medicine" students, Bulgarian- and English-language training programmes at the Faculty of Dental Medicine has been organized since 2016. By completing their higher education, respectively residency in medicine and dental medicine, colleagues already have significant amount of experience and knowledge of the problems related to OSA, which today they apply successfully in their practices [3]. Since 2016, each year, the World sleep day is celebrated in Medical University – Varna.

On Fig. 3 authors demonstrate their personal diagnostic workflow when diagnosing and treating patients at risk for developing obstructive sleep apnea and snoring syndrome, while working in multidisciplinary teams of medical

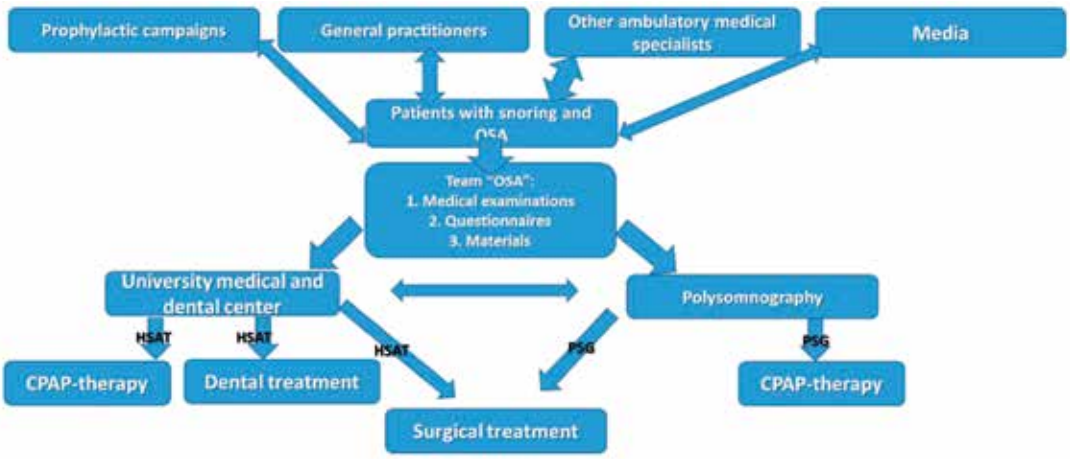

Figure 3: Diag nostic scheme when diagnosing and treating patients with possible obstructive sleep apnea

specialists. Authors work in a close collaboration with: pulmonologists, cardiologists, specialists in sleep, physicians in dental medicine, endocrinologists, pediatricians in order to gather the needed diagnostic information.

The collaboration with pediatricians helped to diagnose and assess the onset of OSA at an early stage. According to a study of Leibovitz and colleagues [26], dentists working with pediatricians', sleep- and ENT-specialists' can aid to better diagnose and treat sleep apnea. The team of specialists behind this study had always been working with the help of pediatricians when OSA in childhood age was suspected. Results reached in the study coincide with the results reached by other authors in the field of OSA screening, diagnostics and treatment [27-29]. OSA still stays often hidden until disastrous consequences are reached.

The work in multidisciplinary teams can be facilitated by legislative measures. Guidelines, specifically designed for hospitals and wards, working with adult and pediatric cases of OSA, can ease the diagnostic burden, often following the case.

The results of the authors' research are not intended to place the problems of sleep apnea as the most important, but to present the objective facts and direct the attention of specialists in the direction of better diagnosis, hence treatment, increasing the quality of life of the patients affected.

Conclusions

Specialists in otorhinolaryngology, head and neck surgery and physicians in dental medicine should work more and in better collaboration when examining and prescribing treatment of OSA

patients in our country. Diagnostic information acquired can be supplemented by the examinations executed from both and close to the anatomic field medical specialists. Other clinicians, for instance cardiologists, pulmonologists, endocrinologists, specialists in sleep medicine can add up vital diagnostic information. Organizing scientific events and symposia, accompanied by practical courses, significantly helps specialists to improve their knowledge and diagnostic skills in the field. Dental professionalists can often be the first to encounter a patient with hidden and non-diagnosed sleep apnea. They can significantly aid the screening and disease management process. Dental treatment of OSA alleviates the symptoms of the disorder. More efforts should be invested in educating dental professionals, students and residents in OSA symptoms and screening.

References

1. Duran J., Esnaola S., Ramon R., lztueta A: Obstructive sleep apnea-hypopnea and related clinical featunts in a population-based sample of subjects aged 30 to 70 years. Am J Respir Crit Care Med. 2001, 163:685-689. 10.1164/ajrccm.163.3.2005065.
2. Duran-Cantolla J., Mar J., De la Torre G., Rubio G., Guerra L: El sindrome de apneas-hipopneas durante el sueno (SAHS) en Espana. Disponibilidad de recursos para su diagnostico y tratamiento en los hospitales del estado espanol · Arch. Bron-coneumol. 2004, 40:259-67. 10.1016/S0300-2896(04)75517-9.
3. Milkov, M: Prevention of obstructive sleep apnea in professional drivers (https://books.mu-varna.bg/en/product/3183/.html). Medical University – Varna Publishing house (ed): 20219786192213237, Bulgaria; 2021.
4. Martinez Garcia M.A., Quintano Jimenez J. A. Soler Cataluna J: Situacion actual del SAHS en atencion primaria. Apnea del sueno (ed):
5. National Commission on Sleep Disorders Research: Wake up America: a national sleep alert (https://scholar.google.com/scholar?q=intitle:Wake%20up%20America%3A%20a%20national%20sleep%20alert). Washington, D.C.: Government Printing Office. 1993,
6. Guilleminault C., Eldridge F.L., Dement W.C: Insomnia with sleep apnea: a new syndrome. Science. 1973, 181:856-8.10.
7. Guilleminault C., Tilkian A., Dement W.C: The sleep apnea syndromes. Annu Rev Med. 1976, 27:465-485. 10.1146/annurev.me.27.020176.002341.
8. Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S: The occurrence of sleep-disordered breathing among middle-aged adults. N Engl J Med. 1993, 29:1230-5. 10.1056/NEJM199304293281704.
9. Duran J., Gonzalez Mangado N., Madn J.M., Solans M., Zamarron C., Montserrat J.M: Concepto, definicion y epidemiologia del SAHS. Arch Bronconeumol. 2002, 38:3-9.
10. American Academy of Sleep Medicine. Sleep-related breathing 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. 1999, 22:667-89.
11. Sleep-related breathing 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. 1999, 22:667-89.
12. "Understanding the Results: Sleep Apnea". med.harvard.edu. Harvard Medical School, Harvard University. Retrieved 5 September (https://sleep.hms.harvard.edu/education-training /public-education/sleep-and-health-education-program/sleephealth-education-34). (2014).
13. Ruehland WR, Rochford PD, O'Donoghue FJ, Pierce RJ, Singh P, Thornton AT (1: February 2009). "The new AASM criteria

for scoring hypopneas: impact on the apnea hypopnea index" (https://dx.doi.org/10.1093/sleep/32.2.150). Sleep. 32. 2:150-7.
14. Bailey, R., Attanasio, R.: Screening and comprehensive evaluation for Sleep Related Breathing disorders. In: Attanasio, R., Bailey, R (Eds), Dental clinics of North America, V. 56, N 2, Saunders, Elsevier, pp, 2012. 331-342.
15. Milkov, M., Nedev, P., Tonchev, Ts. : Our experience with APNEAGRAPH in diagnosis of obstructive sleep apnea and snoring.- In: 3rd Congress of European ORL-HNS. Prague, Czech Republic, 7-11.VI.2015. Poster No 888186). 2015.
16. Milkov M., Petrov P., Radkova D.: Our initial experience with nasal stent application in snoring and mild obstructive sleep apnea, JOURNAL OF SLEEP RESEARCH). 25:347-347.
17. Silva GE, Vana KD, Goodwin JL, et al.: Identification of patients with sleep disordered breathing: comparing the four-variable screening tool, STOP STOP-Bang and Epworth Sleepiness Scale. J. Clin Sleep Med. 2011, 7:467-72.
18. Lavigne GJ, Montplaisir JY: Restless legs syndrome and sleep bruxism: prevalence and association among Canadians. Sleep. 1994, 17:739-43.
19. Travel JG, Simons DG: Myofascial pain and dysfunction the trigger point manual. Baltimore (MD) Williams and Wilkins, 1983.
20. Wright EF: Manual of temporomandibular disorders Ames (IA): Blackwell (ed): 2005.
21. Friedman M, Tanyeri H, La Rosa M, Landsberg R, Vaidyanathan K, Pieri S, Caldarelli D.: Clinical predictors of obstructive sleep apnea. Laryngoscope. 1999, 109:1901-7.
22. Nuckton, T., Glidden, D., Browner, W.: Physical Examination: Mallampati Score as an Independent Predictor of Obstructive Sleep Apnea. Sleep. 2006, 29:903-8.
23. Lee CH, Mo J, Kim BJ, et al.: Evaluation of Soft Palate Changes Using Sleep Videofluoroscopy in Patients With Obstructive Sleep Apnea. Arch Otolaryngol Head Neck Surg. 2009, 135:168-172.
24. Pevernagie, D., De Meyer, M., Claeys, S.: Sleep, breathing and the nose. Sleep medicine reviews. 2006, 9:437-51. 10.1016/j.smrv.2005.02.002.
25. Friedman, M., Syed, Z., Landsberg, R.: The role of nasal obstruction and nasal surgery in the pathogenesis and treatment of obstructive sleep apnea and snoring. Current Opinion in Otolaryngology & Head and Neck Surgery. 2001, 9:158-161.
26. Leibovitz S, Haviv Y, Sharav Y, Almoznino G, Aframian D, Zilberman U: Pediatric sleep-disordered breathing: Role of the dentist. Quintessence Int. 2017;48(8): 639-645.
27. Schiza SE, Bouloukaki I: Screening for obstructive sleep apnoea in professional drivers. Breathe (Sheff. 2020, 16:29364.
28. Evans KA, Yap T, Turner B: Screening Commercial Vehicle Drivers for Obstructive Sleep Apnea: Tools, Barriers, and Recommendations. Workplace Health Saf. 2017, 65:487-492.
29. Garbarino S, Guglielmi O, Campus C.: Screening, diagnosis, and management of obstructive sleep apnea in dangerous-goods truck drivers: to be aware or not? Sleep Med. 2016, 25:98-104.

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