ABSTRACT

Introduction: Obstructive sleep apnea (OSA) is characterized by the cessation of air flow during sleep due to an obstruction in the nasopharyngeal/oropharyngeal region. The consequences that untreated obstructive sleep apnea might have on a patient's health include symptoms like sudden awakening with a sensation of suffocation, morning headache, daytime sleepiness and fatigue, lack of concentration, and it is commonly connected to hypertension, coronary artery disease, depression, obesity and other medical conditions. Aim: The purpose of this review study is to enlighten the role of an orthodontic professional in prevention and treatment of obstructive sleep apnea syndrome to the general public. Methods: Data search was determined by the following keywords: sleep apnea, orthodontic abnormalities, orthodontic prevention, sleep apnea syndrome, obstructive sleep apnea, cephalometric analysis, AHI index, BMI index and obesity. Electronic data search was performed on platforms Pubmed and Google Scholar. Results: After reading and analyses, twenty-one articles with similar procedural criteria were selected, and among them only 6 were recognized as meeting the criteria of being completely accessible, having the selected keywords in their name, using the cephalometric analysis and BMI index and discussing the obese adults sleep apnea. In all the examined studies, it is proven that craniofacial morphology is a major anatomical risk factor for OSA. Conclusion: The role of the orthodontic specialists might be crucial in prevention of the development of obstructive sleep apnea, not only considering the orthodontic devices treatment options, it can be especially important when obesity appears as a factor in the sense of informing and advising the patient and cooperating with other specialists who treat and prevent obstructive sleep apnea syndrome.

Keywords: sleep apnea, orthodontic abnormalities, orthodontic prevention, sleep apnea syndrome, obstructive sleep apnea, cephalometric analysis, AHI index, BMI index and obesity.

1. INTRODUCTION

Obstructive sleep apnea (OSA) is characterized by the cessation of air flow during sleep due to an obstruction in the nasopharyngeal/oropharyngeal region. Many episodes of apnea may take place within the span of minutes leading to the arousal of the patient from his/her sleep in an attempt to increase the amount of air flow (1).

This medical condition is related to a range of risk factors such as age, male sex, menopause, anatomic abnormalities, heritable factors, tobacco and alcohol consumption and obesity (1, 2). The consequences that the untreated obstructive sleep apnea might have on a patient's health include symptoms such as sudden awakening with a sensation of suffocation, morning headache, daytime sleepiness and fatigue, lack of concentration, and it is commonly related to hypertension, coronary artery disease, depression, obesity and other medical conditions.

Airways and craniofacial systems are closely connected and interdependent. During the growth and development they correlate. The orthodontic specialists are the ones that can predict or detect if the improper breathing function is caused by the malocclusion or if the malocclusion is a result of the obstruction in airflow.

Obesity affects a lot of functions of the human body. But how aware are we of its impact on breathing, the most important vital function of the human body? Craniofacial abnormalities and obesity are the two risk factors that can be
of interest for the orthodontic specialist, not just because they are the most important ones, but due to their manageable potential.

The anatomically collapsible upper airway is mostly attributed to obesity, enlarged upper airway soft tissues, and skeletal deformity (5). In particular, skeletal deformities predisposing to the airway collapsibility have been reported to include short cranial base length, acute cranial base flexure, mandibular retrognathism, maxillary hypoplasia, maxillary transverse constriction with or without nasal cavity obstruction, hyperdivergent vertical pattern with steep occlusal and mandibular planes, which result in the pharyngeal narrowing and lengthening with a downward displacement of the hyoid, and backward displacement of the tongue base and soft palate (4).

As a condition, sleep apnea is associated with a multitude of adverse consequences, including the excessive daytime sleepiness, neurocognitive impairment, increased motor vehicle accident risk, diabetes, increased cardiovascular morbidity and all-cause mortality (1).

Can the orthodontic specialist contribute in prevention or management of obstructive sleep apnea, and how? The purpose of this review study is to enlighten the role of the orthodontic professional in prevention and treatment of obstructive sleep apnea syndrome.

2. AIM

The aim of this research was also to identify the most common craniofacial abnormalities in patients with obstructive sleep apnea syndrome in reference to obesity stage that can be found in literature.

3. MATERIALS AND METHODS

A search of database platforms Pubmed, Google Scholar was performed in order to identify relevant papers which examine the association between the orthodontic anomalies and obstructive sleep apnea in adult obese population.

Data search was determined by keywords: sleep apnea, orthodontic abnormalities, orthodontic prevention, sleep apnea syndrome, obstructive sleep apnea, cephalometric analysis, AHI index, BMI index and obesity. Electronic data search was performed on platforms Pubmed and Google Scholar.

Search resulted in the finding of 1293 studies on Pubmed and 1587 on Google Scholar. Studies that pertain to the children population were more numerous, although the prevalence of obstructive sleep apnea is high in adults.

The publishing time limitation for the selection of articles was the period of the previous 20 years. Study selection was performed considering the evaluation based on orthodontic approach and the connection between orthodontic abnormalities and obstructive sleep apnea condition in obese adults, represented by the cephalometric analysis.

4. RESULTS

After readings and analyses, 15 articles with the similar procedural criteria were selected, and among them only 6 were recognized as meeting the criteria of being completely accessible, having the selected keywords in their name, using the cephalometric analysis and BMI index and discussing the obese adults sleep apnea. Those studies were recognized and analyzed in detail in order to describe the direct connection between the orthodontic abnormalities and obstructive sleep apnea syndrome in obese adult population.

The studies that have been analyzed in this literature review were chosen because of their clear and similar representation of obesity and cephalometric factors of obstructive sleep apnea, through similar cephalometric parameters. All the studies in general illustrated the main characteristics, cephalometric values and soft tissue variations in the obese OSA patients and clearly demonstrated that obese patients show an increased cranio-cervical and decreased cervical horizontal angulation.

Although obesity is considered a major risk factor for OSA, the craniofacial morphology is increasingly acknowledged as an important interacting factor in the pathogenesis of OSA (1). Craniofacial characteristics associated with OSA include aspects of skeletal morphology pertaining to the mandible, maxilla, cranial base, hyoid and head position, as well as soft tissue morphology, relating to the size of the upper airway soft tissues (6).

In all the studies, BMI was a significant determinant, and the cephalometric values that were in common for most of the examined studies were: ANB, SNA, SNB, soft palate length, soft palate width, tongue length, inferior upper airway size. In all the examined studies, it is proven that craniofacial morphology is a major anatomical risk factor for OSA. The craniofacial characteristics that are considered to be predominant in OSA include an inferior position of hyoid bone, retroposition of the mandible, long and narrow face, dolichocephalic facial type, narrow and deep palate, anterior open bite, midface deficiency, smaller cranial base, increase of the cranio-cervical extension angle and abnormal upper airway soft tissue morphology. Obesity, being a risk factor for OSAS, may affect upper airway morphology in the absence of the bony craniofacial abnormality. In obese patients who have a distribution of body fat mainly over the upper part of their body, the resistance of the upper airway during sleep tends to be very high (1).

In the non-obese, as well as obese OSAS patients, skeletal changes are often evident, especially in obese (in terms of the intermaxillary divergence), and that, unexpectedly, in obese OSAS patients, the alterations of the oropharyngeal soft tissue are not always present and prevailing (1).

Some studies referring to the cephalometric analysis of bone structures do not find any significant differences between the cephalometric image in obese and non-obese patients (8, 9). The results show that the main difference between the obese and non-obese patients with OSA is in the soft tissue variations. It could be argued quite correctly that the changes in the soft tissue and body facial anatomy may interfere with the upper airway collapsibility (1).

In conclusion, the present studies found that in the non-obese as well as obese OSAS patients, skeletal changes are often evident, especially in the obese (in terms of intermaxillary divergence), and that, unexpectedly, in obese OSAS patients, the alterations of the oropharyngeal soft tissue are not always present and prevailing (8, 9).

The increased hyoid distance, tongue length, soft pal-
The Link Between Obstructive Sleep Apnea and Orthodontic Anomalies in Obese Adult Population

A strong relation between obesity and OSA is strengthened by the evidence that weight loss is followed by the clinically proven improvement in the severity of OSA (1). Obesity is a modifiable risk factor, unique among the other risk factors for obstructive sleep apnea (1). Only few of the examined studies predict strong recommendations for the orthodontic specialists and other medical specialists in diagnosing and treating the OSA patients. There is an increasing interest in the role of the orthodontist both in screening for obstructive sleep apnea (OSA) and as a practitioner who may be valuable in the multidisciplinary management of OSA in both children and adults (1).

| Author                | Sample size | Cephalometric parameters, BMI; AHI | Orthodontic characteristics | Recommendations                                                                 |
|-----------------------|-------------|------------------------------------|-------------------------------|---------------------------------------------------------------------------------|
| Su-Jung Kim et al.(4) | 2120        | SNA, SNB, and ANB, FH-MP, PHF, AHF | mandibular retrusion, maxillary retrusion and bimaxillary retrusion | precision treatment decision in pursuit of personalized approach for OSA, weight loss |
| Tae Hoon et al.(14)  | 93          | distance from mandibular plane to hyoid, distance from velum tip to pharyngeal wall parallel to Frankfurt horizontal line, condyle to gnathion-total mandibular length, soft palate thickness, SNA, SNB, AH; BMI | fat deposits around the pharynx, hypertrophied adenoids and tonsils, macroglossia, retrognathia and micrognathia | weight loss                                                                  |
| Sutherland K. et al.(5) | 62         | smaller cranial base, increased anterior facial height and increased craniofacial angle | narrow and tapered maxillary arch, mandibular deficiency, inferior displacement of the hyoid bone | weight loss                                                                  |
| Öztürk et al.(7)     | 85          | BMI, AHI, palate thickness, mandibular plane angle (SNGoGn°), SNA°, SNB°, ANB°, anterior face height, ramus height, uvula length and lower face height | bimaxillary prognathism and relatively greater facial measurements, inferior position of hyoid bone | weight loss                                                                  |
| Thapa et al.(10)     | 178         | 21 cephalometric variables, AHI and BMI | longer tongue, more anteriorly displaced hyoid bone, and more anterior displacement of mandible, increased length of soft palate and soft palate thickness | -                                                                             |
| Cho SH et al.(15)    | 288         | ANB angle from A point to nasion to B point, SPL soft palate length, SPT soft palate thickness, RPS retropalatal space, RLS retrolingual space, MPH mandibular plane to hyoid; body mass index, neck circumference, and waist-hip ratio | retrognathia, micrognathia, long face, inferior positioning of the hyoid bone, reduced cranial base length and angle, large ANB angle, steep mandibular plane, elongated maxillary and mandibular teeth, narrowing of the upper airway, long and large soft palate, and large tongue | -                                                                             |

Table 1. Cross-section of the literature and authors on the subject

ate length and thickness, and the anteroposterior palatal distance may play a significant role in the severity of OSAS and can be considered as important inputs for diagnosis and treatment planning (1).
The Link Between Obstructive Sleep Apnea and Orthodontic Anomalies in Obese Adult Population

5. DISCUSSION

Obesity has mechanical effects because of the fat tissue deposition around the upper airway anatomical structures, consequently narrowing the upper airway. It is also connected with a reduction of lung volume and as a result of that mechanical effect there is upper airway narrowing, collapse and airflow obstruction (1). Fat tissue may also modulate the upper airway neuromuscular control as it directly induces inflammatory state, because it acts as a source of cytokines-adipokines, inflammatory factors and substances such as leptin which are known to have a depressive effect on the CNS activity and neuromuscular control (1-3). It is proven that weight loss is one of the highly effective sleep apnea treatments. A reduction in 10 to 15% in body weight is proven to reduce sleep apnea severity by 50% as the studies show (2, 3). Furthermore, sleep apnea in obese patients may be aggravated by the increased collapsibility of the upper airway rather than the decreased size of the upper airway (1).

In most of the analyzed studies, the obese group had more severe sleep apnea than the non-obese group. The connection between results of all the examined studies made us believe that the increased severity of apnea in the obese group may be a result of the increased collapsibility of the upper airway rather than the decreased size of the upper airway.

The distance measured from the hyoid bone to posterior pharynx is smaller in non-obese patients as it is the case with a smaller ANB angle, so the main reason besides the anatomic and neuromuscular variables might be in the fat tissue neck deposition that shifts the hyoid bone caudal and causes a greater upper airway collapsibility.

It is important to underline that the upper airway anatomy measured with lateral cephalometry had different characteristics and associations with AHI and central obesity, depending on sex (1).

Literature often describes the influence of obesity in obstructive sleep apnea syndrome by referring to the central and peripheral fat tissue deposition. Studies that use cephalometric analysis show that it is not only the physical obstructive effect of fat tissue on airway that can worsen up the obstructive sleep apnea condition, but also the effect that the fat tissue has on bones and their position (4, 5, 7, 10-15). It is imperative that the orthodontic specialists understand the comorbidities associated with obstructive sleep apnea and its increased risk of morbidity and mortality.

The clinical approach to the treatment of obstructive sleep apnea in adults has to be comprehensive and multidisciplinary. Treatment of obesity is one of the most effective and beneficial solutions. All of the examined studies which were looking into the correlation between the cephalometric analysis, orthodontic anatomy and obesity are very clear in a sense of obesity and cephalometric anatomy structures impacting sleep apnea stages and factors.

6. CONCLUSION

It is clear that obesity affects the cephalometric image of a patient and therefore also has severe impact on sleep apnea condition. It is important to understand and to be aware of the impact that obesity has in the development and management of obstructive sleep apnea.

The treatment of obstructive sleep apnea in obese patients should include a range of different professionals because of its complexity.

The role of the orthodontic specialists in the prevention and management of obstructive sleep apnea syndrome can be deciding if we have in mind that an orthodontic specialist can predict skeletal changes and growth and recognize a potential problem at an early age and can advise and treat the patient at an early age or even later.

The role of the orthodontic specialists might be crucial in the prevention of the development of obstructive sleep apnea not only when it comes to orthodontic devices treatment options, it can be especially important when obesity appears as a factor in the sense of informing and advising the patient and cooperating with other specialists who treat and prevent obstructive sleep apnea syndrome.

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