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Review

SEJODR

Relationship between obstructive sleep apnea and orthodontic malocclusion in non-obese adults: Review

Jašarević, Dženana *; Nakaš, Enita *; Tiro, Alisa*

** Department of Orthodontics, School of Dental Medicine, University of Sarajevo*

ABSTRACT

Introduction: Obstructive Sleep Apnea (OSA) represents the complete or partial obstruction of the airway. Clinically OSA manifests as sleepiness during the day, heavy snoring, and waking up during the night due to lack of air. Obesity, gender and orthodontic anomalies are listed in the literature as the etiologic factor of OSA.

Aim: This study aimed to find the correlation in the analyzed studies between OSA and orthodontic anomalies in non-obese adults.

Material and methods: The electronic search of the database was performed (PubMed and Google Scholar) to find relevant articles that correlate orthodontic anomalies with OSA. Keywords included: obstructive sleep apnea, orthodontic anomalies, cephalometric analysis, impact, association, body mass index, obesity, adults, non-obesity. Included criteria: non-obesity, a study published from 1999-2019, a study in English, full text.

Results: Two hundred papers included keywords. The number of papers that included the full set criteria was nine. These nine papers were analyzed in detail.

Conclusion: Analyzed articles showed that there is a correlation between Obstructive sleep apnea (OSA) and orthodontics malocclusion in non-obese adults.

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INTRODUCTION

Obstructive sleep apnea has been in many studies correlated with many diseases such as increased incidence of heart attack, hypertension, type 2 diabetes and cognitive complications.[1]

Breathing problems that occur during sleep can be defined as apnea, hypopnea and hypoventilation.

OSA occurs when there is a partial or complete lack of air, but respiratory processes are still taking place. Clinically, obstructive sleep apnea (OSA) causes trouble sleeping, snoring, headache, drowsiness, and waking up during the night due to lack of air. OSA is thought to affect 8% of the male population and 2% of the female population.[2] Further research has shown that many patients are unaware that they have OSA because they do not have clinical symptoms. In his research, Young showed that 93% of the female population and 82% of the male population were not clinically diagnosed with the presence of OSA.[3]

Corresponding Author:
Dzenana Jašarević
Sarajevo, BiH.
E-mail: dzenanaze@hotmail.com

Obstructive sleep apnea can be diagnosed based on AHI (Apnea-Hypopnea Index). Strohl and co-workers defined OSA in two ways:[4]

1. If the AHI is greater than 15 apnea, hypopnea within one hour of breathing in asymptomatic patients
2. If the AHI is greater than 5 apnea, hypopnea during one hour of sleep in symptomatic patients (drowsiness, snoring, pauses in breathing)[5].

The etiology of OSA is diverse. The causes of obstructive sleep apnea could be obesity, alcohol consumption, other central nervous system depressions and anatomical factors such as retroposition of the mandible, position or size of the tongue, position of the hyoid bone, etc.

The nasal cavity, pharynx and larynx create a pathway for air to pass from the nose to the lungs while also participating in other physiological functions such as phonation and swallowing.[6]

The anatomical location of upper airway obstruction can be anywhere from the nose to the glottis, with the most common primary obstruction at the soft palate and oropharynx level.[7] Since the upper airway is part of the craniofacial system, the growth and development, as well as anatomical irregularities, affect the patency of the upper airway. Airway obstruction was first described in 1869 in Meyer's research in which he cites the occurrence of mouth breathing as a consequence of upper airway obstruction.[8]

The craniofacial system's bony structures that determine the airway's size and width are mandible and hyoid bones, which are the anchors for soft tissues and muscles.[9] The disturbance in growth and development can lead to an incorrect position of the mandible and hyoid bone, leading to improper binding of soft tissues and muscles and impacting the size and width of the airway. Changes in any of the above mentioned structures can lead to reduction of the volume of the pharynx. Such changes affect the flexibility and resistance of the upper respiratory tract to air flow.[10]

In 1907, Angle described upper airway obstruction as one of the etiological factors of malocclusion.[11]

Structures of the craniofacial system(hyoid bone, mandible, soft tissues and muscles) that reduce the space for the tongue (large tongue) or the mandible's retrognathic position have been accepted as the causes of obstructive sleep apnea.

Today, awareness of obstructive sleep apnea and the consequences it can have on human health is growing. Based on that, treating sleep disorders and the etiology of their occurrence should become a part of orthodontic practice. This study aimed to find the correlation between Obstructive sleep apnea (OSA) and orthodontic anomalies in non-obese adults, as we wanted to exclude obesity as a factor in OSA.

MATERIAL AND METHODS

The review work was done by the method of electronic database search (Pubmed and Google scholar). The search algorithm was defined by keywords, time of publication of articles, availability of research, a language in which they were published, and data relevance.

Keywords included: obstructive sleep apnea, orthodontic anomalies, cephalometric analysis, impact, association, body mass index, obesity, non-obesity.

Inclusion criteria are presented in table 1. Keywords included: Obstructive Sleep Apnea (OSA), orthodntic anomalies, Cephalometric analysis (LCG), impact, association, Body Mass Index (BMI), obesity, non-obesity, adults.

The search engine is set to display papers published in English in the period from 1999 to 2020. Studies with Craniofacial syndromes were excluded. Articles with incomplete data and those that did not have significant results were excluded. The presence of a control group, follow-ups, the number of respondents were not clearly defined and as such they were not set as limits.

Table 1. Inclusion criteria

Identification process	Records identified by electronic data base Pubmed and Google scholar
Keywords search	Obstructive sleep apnea(OSA); orthodontic anomalies; cephalometric analysis; Body mass index(BMI), obesity, non-obesity, adults.
Inclusion criteria	adult patients, orthodontic anomalies, Apnea-hypopnea index>5, Body mass index<30
Included studies	9 studies were analyzed in detail (785 patients presented)

RESULTS

Typing keywords shows a large number of papers. Two hundred papers included keywords. The number of papers that included the full set criteria was nine. These nine papers were analyzed in detail. The papers represented human studies. The studies met the criteria as follows: the subjects were non-obese (body mass index less then 30 kg/m^2); OSA was diagnosed based on AHI index and polymorphography; whether they had an orthodontic anomaly; whether a lateral cephalogram analysis was performed.

The same cephalometric analysis (Tabel 2) was used in papers to show the presence of orthodontic anomalies and the pharyngeal space's width. The angles used to analyze the position of bone structures are SNA, ANB, SNB. Mp-H was used to analyze the position of the mandible relative to the hyoid bone.

Four papers based their research on the association between obstructive sleep apnea and orthodontic anomalies in non-obese individuals.

Three papers are based on a surgical method of treating orthodontic anomalies and monitoring the improvement of OSA. In these studies (Table 3), the subjects met the set research

Table 2. The most used parameters in studies for lateral cephalogram analysis

ANGULAR PARAMETERS	
SNA	Representing the position of the maxilla with the cranium
SNB	Representing the position of the mandible with the cranium
ANB	Representing the relationship of maxilla and mandible with the cranium
MP/SN	Representing the mandibular inclination
LINEAR PARAMETERS	
MPH (mm)	The perpendicular distance from H (the most superior and anterior point on the body of hyoid bone) to mandibular plan
PNS-P (mm)	Distance between posterior nasal spine and tip of the soft palate
PAS (mm)	The thickness of the airway behind the soft palate along a line parallel to the Go-B point plane

criteria: that the BMI was less than 30, they had an LCG (lateral cephalogram) analysis and an orthodontic anomaly.

The orthodontic anomalies associated with OSA and described in these studies are mandibular retrognathia and total maxillary narrowness.

Two studies also analyzed dental models and showed correlations between the presence of overjet and obstructive sleep apnea.

Table 3. *Studies included (the full set criteria)*

INCLUDED STUDIES	Year of publication	Sample size
Etsuko M et al. [12]	2008	97 (all male patients)
D.S. Rossi et al. [13]	2019	8 (7 males; 1 female)
E.K. Pae et al. [14]	1999	33 (male)
Watanabe T et al. [15]	2002	78 (male)
A. Thapa et al. [16]	2015	104 (male)
Tsuiki S et al. [17]	2008	134 (male)
H. Sakakibara et al. [18]	1999	151 (male)
K. Maeda et al. [19]	2014	164 (male)
P.P. Vinha et al. [20]	2020	16 (9 male; 7 female)

DISCUSSION

Of all the studies analyzed, a study by Myao et al. [12] in 2008 showed a consistent association between OSA and orthodontic anomalies. The number of subjects included in the study was 97.

The results of this study showed that overjet in non-obese patients was present in 43.3% of subjects. There was also a difference in the SNB angle, which showed the retroposition of mandible in non-obese patients. It was concluded that an increase in AHI resulted from an increase in overjet. This study showed that craniofacial structures can be a leading factor in OSA development in patients with a normal Body Mass index (BMI).

In this study, as well as in previous studies based on the analysis of Lateral cephalogram, it was concluded that a shorter length of the mandibular body, mandibular retroposition and increased overjet are the reasons for the occurrence of OSA.

Partial confirmation of this study can also be shown in the work of Sergio Rossi [13] and co-workers who showed a reduction of AHI index by 50% in non-obese patients after performing the Maxillo Mandibular advancement (MMA) surgical procedure. They used the same criteria to select subjects as in the previous study: BMI of less than 27, patients with severe clinical picture of OSA, adult patients and analysis of LCG image with analysis of similar angular parameters on LCG. Their results concluded that by increasing the SNB angle by 6.3 degrees, we come to an increase in the PAS area (thickness of the airway behind the soft palate along a line parallel to the Go-B point plane) diameter by 7.41 mm. The disadvantage of this study was the small number of subjects (nine in total). However, it showed that MMA is an effective surgical procedure in the treatment of OSA.

The results of the studies (14-16)revealed significant data showing the association between OSA and orthodontic anomalies. Estuko[14] and co-workers showed a difference in certain parameters on the LCG (lateral cephalogram) between obese and non-obese subjects, in a study where 33 subjects selected by BMI of less than 27. In subjects with a BMI less than 27, they showed that the lower face height was shortened and that the overbite was more pronounced, which they associated with a shorter length of the mandibular body or retroposition of the mandible.

They also showed that the oral cavity was smaller in subjects with a reduced lower third part of the face, leading to insufficient space for tongue placement that could lead to the onset of OSA. Cranio and dentofacial characteristics that decrease the tongue space such as large tongue or a small rethrognathic mandible are widley accepted as a factors that lead to the development of obstructive sleep apnea.[15,16]

They confirmed that the etiology of OSA in obese and non-obese subjects is not the same. Confirmation of this research was given by Thapa and co-workers [17] who measured the width of the pharyngeal space on the basis of LCG and showed that the position of the hyoid bone affects the formation of OSA in non-obese patients. All three studies used almost the same parameters to analyze the LCG image.

It is accepted that cranio and dentofacial anomalies that reduces the space for the tongue (such as small retrognathic mandible) can develop the obstructive sleep apnea.

Sakakakibara and co-workers [18] came to the same conclusion by conducting a study investigating the analysis of LCG (lateral cephalogram) imaging in patients diagnosed with the presence of OSA based on a clinical questionnaire and AHI index. They confirmed that the etiology of OSA in obese and non-obese subjects is not the same.

Maeda and associates [19] conducted research on a 164 respodents. The diagnosis of OSA in the subjects was the same as in the previously analyzed studies. The analyses of orthodontic anomalies was performed on the basis of the analyses of dental models and the analyses of the LCG (lateral cephalogram) image. They concluded based on the SNB angle that the formation of OSA is influenced by the mandible position and the bones of the craniofacial system. However, they also found a connection between the AHI size and the transverse underdevelopment of the maxilla.

We found confirmation of this research in the study of Vinha et al [20]. In their study, they showed that 56.24% of AHI changes occur after SARME. The selection of subjects was done in the same way as in previous studies. A 24% increase in the width of the lower pharyngeal space after surgery tells us that maxillary constriction has an effect on the severity of the clinical picture in OSA, because after surgery in patients with a milder clinical picture of OSA the results were not significant because there was no reduced AHI. They have shown, as in previous studies, that increasing the maxilla in transverse width leads to an increase in the space for the tongue, which frees the lower airways and allows a decrease in AHI.

Recent studies [21] confirmed that oropharyngeal volume is increased by using the RPE. Showing that solving the orthodontic malocclusion we can solve the OSA in patients.

CONCLUSION

This review showed that orthodontic malocclusion is correlated with OSA and they can be defined as an etiological factor for OSA in non-obese adults. Development and severity of Obstructive sleep apnea is correlated with orthodontic malocclusion in non-obese adults.

All studies analyzed in detail, including this review, concluded that by early recognition of orthodontic irregularities and their treatment, we could prevent the development of OSA or enable the formation of a milder form if another etiological factor is responsible for the same occurrence.

Limitations of the study: Only English literature was search and electronic databases, no other literature was reviewed.

CONFLICT OF INTEREST

The authors declare that they have no competing interests. No funding was received.

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