



Orthodontics as a therapeutic tool for managing sleep apnea: A review

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ABSTRACT

Introduction: Sleep apnea is a disorder in which the person's breathing is interrupted periodically at night due to the physical blockage of the airway. Determining the best way to treat their sleep disorders requires careful studies, tests, counseling and various examinations. Orthodontics is the best way to get a patient to have oral equipment. The use of orthodontic equipment is a non-surgical and effective treatment for mild to moderate sleep apnea. The aim at this study is a systematic review and meta-analysis of orthodontics as a therapeutic tool for managing sleep apnea.

Materials and Methods: At first, all the papers (n=112) related to keywords (orthodontics therapeutic tools and sleep apnea) were searched for English databases; Google, Google scholar, PubMed, Embase, Cinahl, PsycInfo, and Cochrane Database of Systematic Reviews covering the period from 2010 through 2019 was studied. Then, papers related to orthodontics therapeutic tools of sleep apnea were selected and analyzed (n=8). As a result to inclusion and exclusion criteria, papers related to orthodontics therapeutic tools of sleepapnea were found and analyzed (n=8). Predefined inclusion and exclusion criteria were: papers related to orthodontics therapeutic tools of sleepapnea, papers were English, papers were original and all the papers were free full text.

Results: In the initial search, 112 papers were found that after reviewing the titles and abstract articles and removing repetitive and non-related ones, 26 possible related articles were investigated. Of these, 18 papers were omitted from the abstract because of lack of access to the original article and lack of sufficient information. Finally, 8 papers were included in the study. Data were collected based on study characteristics, measures of orthodontics therapeutic tools, prevalence rates and factors associated with sleep apnea. Orthodontics therapeutic tools for sleep apnea are very important and can play very significant role in health improvement. So, paying more attention to benefits of orthodontics therapeutic tools in sleep apnea is necessary. On important points is the orthodontist's active role play in screening the patients for this disease and advice oral appliance therapy, if needed.

Conclusion: The most effective treatment for sleep apnea and snoring is orthodontics therapeutic tools. Orthodontics therapeutic tools are effective treatments for sleep apnea, snoring and night snoring. Orthodontics therapeutic tools are low cost, easy to use, portable and need little maintenance.

Keywords: Therapeutic tools; Orthodontics; Sleep apnea; Systematic review; Meta-analysis.

Introduction

Sleep apnea is a disorder that obstructs the respiratory tract during nighttime sleep due to many factors. This disorder deprives the person and his/her sur-

roundings of a comfortable sleep [1]. The exacerbation of sleep apnea can cause heart disease and even a heart attack [2-4].

Sleep apnea syndrome is a common disorder and it is estimated that 4% of men and 2% of women suffer from it [5-6]. The clinical symptoms associated with this disorder include nocturnal insomnia, daytime sleepiness, habitual snoring, and cognitive dysfunction [7]. Sleep apnea can have serious consequences if left untreated. Severe drowsiness during the day can increase the risk of vehicle accidents and decrease the quality of life. Neurological cognitive impairments can lead to poor performance at school and at work. The intermittent depletion of tissue oxygen, increased neural activity, endothelial damage, and increased inflammation lead to problems in metabolic function and nerve endings [8]. Left untreated, sleep apnea can increase the risk of insulin resistance, coronary heart disease, congestive heart failure, myocardial infarction, hypertension, cardiac arrhythmia, and sudden death as a result of heart failure [9]. Therapeutic remedies for this disorder are sufficient to treat mild, usually life-changing behavior such as weight loss and smoking cessation. If these do not work, it will help in the final cases of surgery [10]. Oral and dental procedures are effective treatments for the treatment of sleep apnea, snoring and night snoring [11-16]. Orthodontic treatment can be a key in the treatment of sleep apnea because it is often in whole or in part due to respiratory distress caused by structural problems [17]. Orthodontic treatment for sleep apnea through the use of modern innovative technology has become one of the most basic treatments for apnea or respiratory distress and other sleep-related disorders, such as snoring [18]. Orthodontic treatments include orthognathic surgery and maxillary expansion, as well as oral equipment [19-24]. Numerous studies have shown that the small size of the jaw can affect airflow passage and lead to or aggravate obstructive sleep disorders. Some patients with obstructive sleep apnea, whose jaw size is small, receive orthodontic treatment as a child, as their teeth become very irregular [25]. According to studies performed by the dentists, there has been a link between sleep disorders and orthodontics; they found that extracting two bifurcates in childhood is a strong sign of sleep disorders during adulthood [26]. Orthodontic procedures, especially invisalign, increase the size of the oral cavity and eliminate orthodontic problems that usually cause sleep disturbances [27]. In applied orthodontics, the treatment of jaws is more difficult than repairing incorrect teeth. For this reason, aligning the jaws is one of the difficult orthodontic treatments [28]. Rapid maxillary expansion (RME) is an orthodontic treatment that widens the palate and nasal passages, thereby increasing airway patency and reducing the nocturnal obstruction. RME

can be used for children with OSA and narrow palate (crossbite) who have little adenotonsillar tissue or for those with residual OSA after adenotonsillectomy [29]. The board of trustees of the American Association of Orthodontists (AAO) tasked a panel of medical and dental experts in sleep medicine and dental sleep medicine to create a document designed to offer guidance to practicing orthodontists on the suggested role of the specialty of orthodontics in the management of OSA [30]. Kulshrestha et al. (2016) highlighted the role the orthodontist plays in the diagnosis and treatment planning of OSA patients [31].

The significance of the presenter view is that its findings can be used as a guide for researchers both in the academy and medicine who plan to work on orthodontics therapeutic tools for managing sleep apnea, select the components of their formulations, and plan their future studies and experiments. So this review paper attempts to introduce orthodontics therapeutic tools with a brief overview of using therapeutic tools for managing sleep apnea and discuss the applications of orthodontics in reducing the symptoms of sleep apnea and the benefits that can be gained through the use of these therapeutic tools in sleep apnea.

Materials and Methods

In this study, a systematic review and meta-analysis of all researches works on determining the most important application of orthodontics therapeutic tools for managing sleep apnea according to previous studies till 2019 was used. The method of presentation of data in this work, including the determination of the problem under study, data collection, analysis and interpretation of findings were done based on the systematic study reporting system i.e. . The above-mentioned protocol was used as a criterion for searching the papers. There was a time limit for conducting electronic searches (2010-2019). To access the information requested from the studies related to our title by using some keywords (orthodontics therapeutic tools, and sleepapnea) searched for E Google, Google scholar, PubMed, Embase, CINAHL, PsycInfo, and Cochrane Database of Systematic Reviews. Inclusion and exclusion criteria were: papers related to orthodontics therapeutic tools or sleepapnea, papers were English, types of papers were original and all the papers were free full text. In order to maximize the search comprehensiveness, the list of sources for all articles related to the subject was handled in a handy manner to find other possible sources. The main inclusion criterion of articles into this structured review was papers published

in English that examined the application of orthodontics therapeutic tools for managing sleep apnea. If there were multiple reports from a study, the most complete one would be chosen. In cases where the full text of the article was not available, the information in the abstract was used, and if the abstract of the article did not provide enough information, that article was excluded from the study.

To select papers and data collection, the subjects of all papers reached by two of the contributors to the study and repetitive papers were omitted initially, so the subject and abstract of the remaining papers were carefully examined and papers with no criteria for entering this structured review were omitted. Finally, the full text of the probably associated papers was investigated; eligible papers were chosen and omitted from the non-relevant ones. Finally, associated with the inclusion and exclusion criteria 8 papers were found and analyzed.

Data were collected based on study characteristics, measures of orthodontics therapeutic tools, prevalence rates and factors associated with sleepapnea. The PRISMA guidelines were followed in performing this systematic review. To avoid subversion, extraction, and evaluation of the quality of papers was done by two independent researchers. If the papers were not submitted, the reasons for refusing it were mentioned. If the papers were not submitted, the reasons for refusing it were mentioned. In case of controversy between the two researchers, the review was done by a third person. The next step was to obtain, the following information on the selected papers the first author name, the year

and place of the study, the publication year, the sample size, general characteristics of the samples, orthodontics therapeutic tools, and the reported results in the study. The form has been pre-registered. For quantitative and qualitative evaluation of the papers, a systematic review of the choice bias (random sequence generation and allocation concealment) implementation (blindness of participants and evaluators), diagnosis (statistical analysis blindness), sample loss out of the study after randomization, and reporting (selective outcomes report). For this purpose, the risk of bias tool of the Cochrane collaboration group was used. We excluded papers according to inclusion criteria such as papers related to orthodontics therapeutic tools and sleepapnea, papers were English, types of papers were original and all the papers were free full text that the information depicts on the Fig. 1.

Results

Literature search

Initially, 112 references (Figure 1) were retrieved from the primary databases, among them 86 duplicate references. An additional 18 references were excluded by two independent reviewers based on the abstract and title as the studies were not limited to therapeutic therapy as the treatment modality of sleep apnea (SA). Table 1 summarizes these articles. Full texts of the remaining 8 papers were obtained.

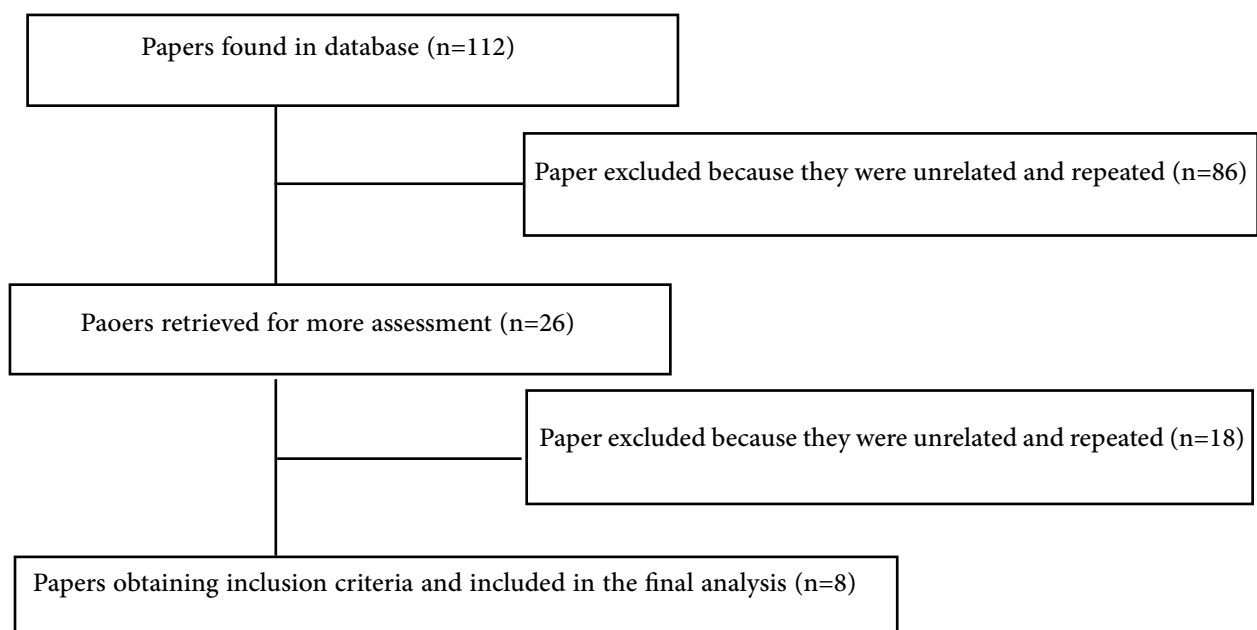


Figure 1. The selection process of papers included in this work.

No	Authors	Objectives	Participants	Orthodontics tools	Classification of sleep apnea	Results
1	Nelly et al. (2015) [32]	Orthodontics Treatments for Managing Obstructive Sleep Apnea Syndrome in Children: A Systematic Review and Meta-analysis	58 Papers	orthopedic mandibular advancement or rapid maxillary expansion	sleep apnea/ obstructive sleep apnea	The findings suggested that orthodontic treatments, may be effective treatments.
2	Rossi and Rossi (2015) [33]	Orthodontics Treatments for Managing Obstructive Sleep Apnea Syndrome in Children: A Systematic Review and Meta-analysis.	8 Papers	functional appliances/ orthopedic devices	sleep apnea/ obstructive sleep apnea	The results showed that orthopaedic devices seem to be a good treatment option for children with OSA
3	Antonio et al. [34]	Combined Orthodontic and Surgical Treatment in a 8-Years-Old Patient Affected By Severe Obstructive Sleep Apnea: A Case-Report	eight-years-old girl	Orthodontic and Surgical Treatment	Sleep apnea/ obstructive sleep apnea	The results revealed that apnea-hypopnea index improved from 21.8 episodes/hr at the baseline to 0.6 episodes/hr, average oxygen saturation from 96.5% to 98.1%, oxygen desaturation events from 23.4 episodes/hr to 1/hr
4	Sanchez-Sucar et al. (2019) [35]	Effect of rapid maxillary expansion on sleep apnea-hypopnea syndrome in growing patients.	10 articles	orthodontic treatment/ rapid maxillary expansion	sleep apnea	RME would appear efficient for treating slight or moderate SAHS, it may be effective as coadjuvant therapy
5	Alessandro et al. (2018) [36]	Obstructive sleep apnea syndrome (OSA) in adolescents: therapeutic management.	----	orthodontic treatments such as rapid maxillary expansion or jaw positioning	sleep apnea /obstructive sleep apnea	The results showed that maxillofacial or craniofacial surgery may be indicated in adolescents with type-3 OSA
6	Colceriu et al. (2018) [37].	Orthodontic appliances in the management of obstructive sleep apnea syndrome - types and therapeutic indications	---	orthodontic treatments	sleep apnea /obstructive sleep apnea	The results represented continuous positive airway pressure (CPAP), orthodontic treatment with various oral appliances can be applied with good results in carefully selected cases

7	Tuncer and Nehir (2016) [38]	The Role of Orthodontics in Diagnosis and Treatment Planning of Pediatric Obstructive Sleep Apnea Syndrome-A Case Report	---	orthodontic treatments	obstructive sleep apnea	The results show that the role of orthodontists during the evaluation and decision making process of sleep apnea treatment will be necessary
8	Jorge et al. (2019) [39]	Obstructive sleep apnea in adults	25 years of OSAS treatment clinical experience	orthodontic treatments/maxillomandibular advancement surgery	obstructive Sleep Apnea	Maxillomandibular advancement surgery is a safe and very effective treatment option to OSAS
9	Ravindar et al. (2019) [40]	Oral appliances in the management of obstructive sleep apnoea syndrome	---	various orthodontic appliances	obstructive sleep apnea	Intraoral appliances in children are advisable, especially in mild-to-moderate cases of OSA, but only after a complete orthodontic assessment of the child's growth and development.
10	Banabilh (2017) [41]	Orthodontic view in the diagnoses of obstructive sleep apnea	Adult	orthodontic practice	obstructive sleep apnea	The results show the demand of integrating sleep into the orthodontic practice shortly will be driven by the need of the societies as some of our patients will be shortly coming into our offices aware of sleep apnea

Table 1. Review of orthodontics therapeutic tool study design, subjects' SA classifications, and outcome measures.

Overview of sleep apnea (SA)

SA is a diagnostic category of disease that encompasses phenomena including primary snoring, upper airway resistance syndrome and SA, along with the related entities of central sleep apnea and sleep related hypoventilation [42]. Sleep apnea (SA) is a condition characterized by repeated episodes of complete or partial airflow cessation during sleep, typically referred to as apnea and hypopnea. Individuals with SA usually present witnessed episodes of snoring, choking, and are more likely to suffer from daytime sleepiness [43]. Types of SA including obstructive sleep apnea (OSA), which partially or completely blocks the airway in the nose and throat, can be caused by large tonsils, large tongue, or excessive tissue in the respiratory tract. Second classification is central sleep apnea (CSA) occurs when the brainstem is damaged in an area of the brain

that controls breathing; the brainstem may be damaged by an infection or stroke [44]. Orthodontics tool is a commonly used as therapeutic method for both types of SA [45-49]. Obstructive sleep apnea (OSA) is one of the most common types of sleep apnea. With OSA, breathing is repeatedly obstructed or restricted for periods of 10 seconds or longer during sleep. Untreated, OSA may raise your risk for high blood pressure, stroke, heart attack, heart arrhythmia or insulin resistance [50-53]. Song et al. (2016) concluded that CSA is caused by lack of input of the central nervous system, obstructive sleep apnea (OSA) is caused by the collapse of the upper respiratory tract, and hypopnea is caused by airflow reduction [54]. Whenever, SA is not related to the obstruction, it seems to result from a central respiratory mechanism, thus conforming to the CSA type [55]. A physical examination is needed to diagnose sleep apnea; your doctor will visit your mouth

and throat for diagnosis. Snoring or feeling too drowsy during the day [56]. Sleep studies are needed to confirm the diagnosis; sleep studies should be traditionally done at a night sleep center, however, recent research suggests that some diagnostics and studies are sometimes performed at home using special equipments [57]. Treatment options for both kinds of SA are different. Oral appliances (OAs) offer a non-invasive treatment option for patients with SA [58]. The American Academy of Sleep Medicine recommends OA therapy for patients with SA [59].

Research data collection

The data collected show that researchers have recorded 112 papers in the English databases; Google, Google scholar, PubMed, Embase, CINAHL, PsycInfo, and Cochrane Database of Systematic Reviews covering the period from 2010 through 2019 was performed. During 2010 to 2019, how much is the scientific papers

of the researchers on the database by type of evidence. The database covers about 5 types of documents, but in this variety of documents, the article is the most documented indexed in this database. Table 2 illustrates this in the scientific output of researchers. In general, as shown in Table 2, the scientific papers of the researchers are indexed in the form of two types of evidence. Articles with 91 titles (81.25%) had the highest share and reviews with 3 titles (2.68%) had the lowest share. The growth of researchers papers over the years shows that researchers scientific paper has been growing since 2010. As can be seen in figures 2 and 3, researchers generally published 112 scientific titles during the years under review. Most articles (21,781%) were published in 2019 and the least (0.848%) in 2010. Scientific paper is added every year and this trend is more pronounced from 2015 to 2019. During this 10-year period, the number of articles rose from 3 titles in 2010 to 24 in 2019.

Document type	Number	Percentage
Article	91	81.25
Conference abstract	7	6.25
Conference paper	7	6.25
Editorial	4	3.57
Review	3	2.68
Total	112	100

Table 2. Frequency distribution of researcher papers in the database by type of document.

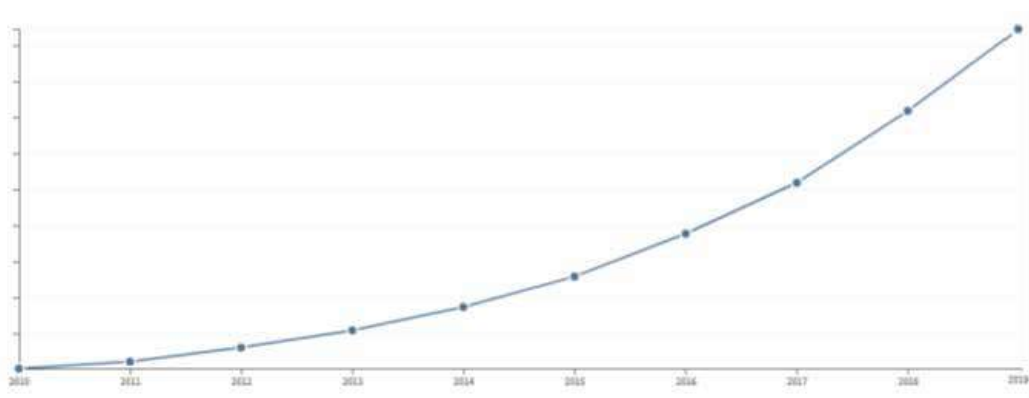


Figure 2. The growth of scientific paper of researchers during the years 2010-2019.

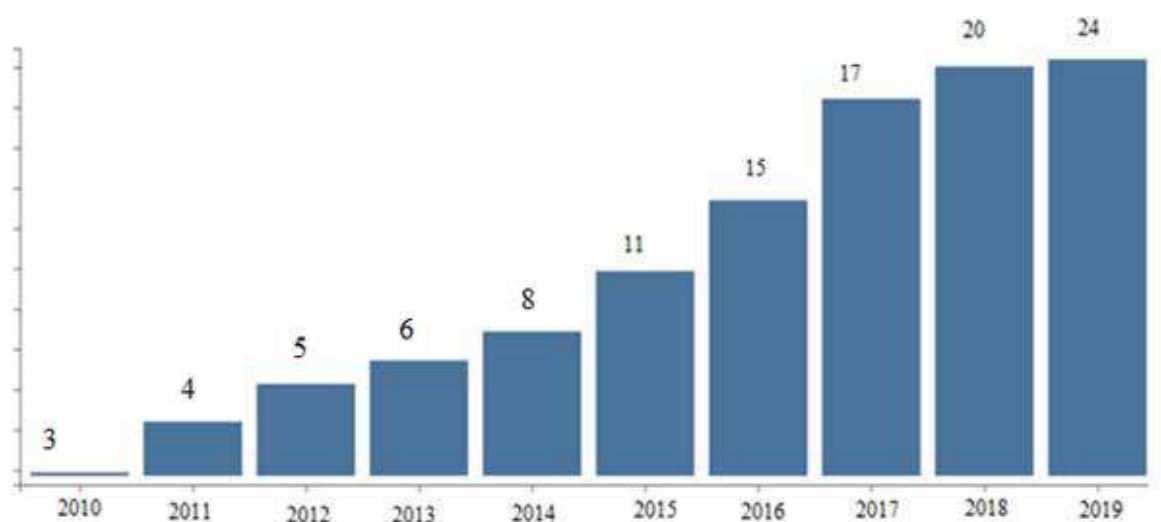


Figure 3. Number of scientific paper titles during 2010-2019.

Discussion

In recent years, SA has received more public attention and is now at the forefront of significant medical concern and areas of research. SA refers to a spectrum of sleep-related breathing abnormalities that include snoring, upper airway resistance syndrome, obstructive hypopnea syndrome, and obstructive sleep apnea (OSA). Early studies suggest that orthodontic therapeutic strategies can help predict success with oral appliances or monitor for sleep apnea with an appliance's use over time. Nelly et al. (2015) investigated the efficacy of orthopedic mandibular advancement and/or rapid maxillary expansion in the treatment of pediatric obstructive sleep apnea. Preliminary studies have suggested that orthodontic treatments, such as orthopedic mandibular advancement or rapid maxillary expansion, may be effective treatments [32].

Rossi and Rossi (2015) demonstrated the effect of using functional appliances in the treatment of OSA in children. The researches studies presented clinical positive results but not statistical results. This systematic literature review showed that orthopedic devices seem to be a good treatment option for children with OSA [33]. Antonio et al. used an anterior collapse of the epiglottis. The treatment involved the rapid palatal expansion, epiglottoplasty and the reduction of the tongue base. Polysomnography revealed that apnea-hypopnea index improved from 21.8 episodes/hr at the baseline to 0.6 episodes/hr, average oxygen saturation from 96.5% to 98.1% and oxygen desaturation events from 23.4 episodes/hr to 1/hr [34]. Sanchez-Sucar et al. (2019) analyzed the evidences available for the effects of rapid maxillary expansion (RME) on SAHS. An electronic search was conducted in the PubMed, Scopus, Embase, and Cochrane databases, and in grey

literature (Opengrey). Ten articles were included for qualitative synthesis and nine for meta-analysis. RME would appear efficient for treating slight or moderate SAHS, as indicated by improvement in oximetric parameters; it may be effective as coadjuvant therapy to adenotonsillectomy in severe cases of children with maxillary compression [35].

Alessandro et al. (2018) believed that orthodontic treatments such as rapid maxillary expansion or jaw positioning are indicated in case of dentofacial disharmonies. The results showed that maxillofacial or craniofacial surgery may be indicated in adolescents with type-3 OSA. Also the treatment of OSA in adolescents is based on the type of OSA, its severity and the medical characteristics of each patient [36]. Colceriu et al. (2018) presented the role of orthodontist in the management of OSAs and reviewed the main validated orthodontic therapeutic strategies. The results represented continuous positive airway pressure (CPAP), orthodontic treatment with various oral appliances can be applied with good results in carefully selected cases [37].

Tuncer and Nehir (2016) reported the importance of clinical inspection and multidisciplinary approach on a patient who suffered from snoring and diagnosed with sleep apnea. The results showed that the role of orthodontists during the evaluation and decision making process of sleep apnea treatment will be necessary [38].

Jorge et al. (2019) provided a narrative review of OSAS from the perspective of 25 years of OSAS treatment clinical experience. MADs are a solid treatment option for primary snoring and mild or moderate OSAS. Patients with severe apnea who are non-adherent to

CPAP may also be treated with MADs. Maxillomandibular advancement surgery is a safe and very effective treatment option to OSAS [39]. Ravindar et al. (2019) emphasized the role of various oral appliances in the treatment of OSA which serve as a guide to clinicians in choosing the proper dental appliance. The treatment options include continuous positive airway pressure, oral appliances and surgical interventions depending on the severity of the condition. Among these, oral appliances are commonly used as primary therapy for the treatment of OSA because these appliances are designed to either encourage maxillary transverse development or advance the mandible, which will significantly reduce the OSA [40].

Banabilh (2017) summarized the clinical and orthodontic observations in the diagnoses of adult obstructive sleep apnea with clinical application in orthodontic practice. The demand of integrating sleep into the orthodontic practice shortly will be driven by the need of the societies as some of our patients will be shortly coming into our offices aware of sleep apnea. However, with our busy clinical orthodontic practice, the need of condense short review become more demanding [41].

Conclusion

This review identified 11 high-quality papers comparing orthodontics therapeutic tool of various designs as inactive tools with different design features in mostly different kind of SA patients. Orthodontic therapeutic devices are increasingly prescribed as a non-surgical treatment option for patients diagnosed with SA. The recommended type of orthodontic therapeutic devices oral is related to the kind and severity of the disorder. Recent studies have shown comparable outcomes of orthodontic therapeutic strategies in reducing SA severity. Therefore, the selection of appropriate candidates for sleep apnea therapy is an ongoing item in order to increase the overall efficacy of the therapy. Finally, the results of the study show that orthodontics therapeutic tools are effective treatments for sleep apnea, snoring and night snoring. Orthodontics therapeutic tools are low cost, portable and convenient to travel and need little maintenance.

Conflict of Interest

There is no conflict of interest to declare.

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