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"INFLUENCE OF RAPID MAXILLARY EXPANSION AND MANDIBULAR ADVANCEMENT IN THE TREATMENT OF OBSTRUCTIVE SLEEP APNEA IN CHILDREN: A REVIEW."

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Resumen

Este artículo presenta alternativas de ortodoncia para el tratamiento de la apnea obstructiva del sueño (AOS) pediátrica. La AOS es una enfermedad multifactorial que afecta el crecimiento craneofacial y la salud general de un niño en desarrollo, empeorando negativamente la calidad de vida. Por lo tanto, la importancia del diagnóstico y tratamiento oportuno de la AOS es fundamental, a fin de evitar el progreso y persistencia de la enfermedad debido a sus importantes consecuencias sistémicas, neurocognitivas y sociales en el paciente. En sentido transversal, la compresión del maxilar determina que haya una disminución del diámetro de las vías aéreas superiores, reduciendo el flujo de aire. Por otro lado, en la dirección sagital, una mandíbula retrognática posicionará la lengua más atrás, reduciendo así el espacio disponible en la vía aérea superior, disminuyendo el flujo de aire durante el sueño. Los tratamientos ortopédicos para la AOS de leve a moderada incluyen la expansión maxilar con dispositivos de expansión maxilar rápida y el avance mandibular con aparatos de avance mandibular, ambos son opciones de tratamiento solo por razones de ortodoncia (esqueléticas) y deben aplicarse después de un diagnóstico individual apropiado para cada paciente de ortodoncia. La evidencia limitada actual sugiere que estas terapias dan como resultado una mejora en los signos y síntomas de la afección, así como una disminución en las puntuaciones del índice de apnea-hipopnea (IAH).

Palabras clave: Apnea del Sueño. Obstructivo. Técnica de expansión palatina. Avance mandibular. Ortodoncia.

Abstract

This article presents orthodontic alternatives for the treatment of pediatric obstructive sleep apnea (OSA). OSA is a multifactorial disease that impairs craniofacial growth and the general health of a developing child, negatively worsening the quality of life. Therefore, the importance of timely diagnosis and treatment of OSA is essential, in order to avoid the progress and persistence of the disease due to its important systemic, neurocognitive and social consequences in the patient. In the transverse direction, the compression of the maxilla determines that there is a decrease in the diameter of the upper airways, reducing air flow. On the other hand, in the sagittal direction, a retrognathic mandible will position the tongue more posteriorly, thus reducing the available upper airway space, decreasing airflow during sleep. Orthopedic treatments for mild to moderate OSA include maxillary expansion using rapid maxillary expansion devices and mandibular advancement using mandibular advancement appliances, are both treatment options only for orthodontic (skeletal) reasons and should be applied after appropriate individual diagnosis for each orthodontic patient. Current limited evidence suggests that these therapies result in an improvement in the signs and symptoms of the condition as well as a decrease in apnea hypopnea index (AHI)scores.

Keywords: Sleep Apnea. Obstructive. Palatal Expansion Technique. Mandibular Advancement. Orthodontics.

Índice

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1. Introduction

Obstructive sleep apnea (OSA) is considered a chronic pathology,[1] it causes a sleep disturbance in which there is recurrent contraction or collapse in the upper airway that causes incomplete restriction of airflow, called hypopnea, or total interruption of airflow for at least 10 seconds during the course of sleep, called apnea.[2–5] The occurrence in childhood ranges from 1.2% to 5.7%, with a higher frequency in boys than in girls.[6]

Pediatric OSA can cause neurodegenerative pathologies,[7] behavioral abnormalities, learning difficulties, and growth retardation,[8] and it is associated with autonomic dysfunction with cardiac arrhythmias and arterial hypertension, remodeling of the ventricular wall, and endothelial involvement, the magnitude is determined by the severity of the OSA[9,10] which impact negatively on the quality of life.[11]

OSA is diagnosed by significant symptoms simultaneously with a sleep study indicating an apnea-hypopnea index (AHI),[11,12] which is acquired by polysomnography (PSG) and has been proved to be the best diagnostic method for OSA.[13–16]

The treatment options for OSA include continuous positive airway pressure (CPAP), surgery, and oral appliances (OA).[17] Although CPAP has been considered the gold standard treatment,[18–20] however it causes intolerance and noncompliance in patients.[20]

The first-line surgical treatment for patients with OSA is adenotonsillectomy,[21,22] however, this procedure may be insufficient to solve OSA[23] especially when there is a significant craniofacial anomaly[13,24] since it is effective in only 25-75% of cases in children.[25] On the other hand, surgical procedures can have severe consequences such as scarring of the soft palate.[3]

OAs may be an alternative or even adjunctive treatment for OSA patients,[26] thus several orthodontic treatment options have been suggested to decrease the symptoms of mild to moderate OSA.[27] OAs, including rapid maxillary expansion (RME) and mandibular advancement appliances (MAA) might be a valuable alternative treatment in children with OSA related to craniofacial anomalies.[28] The success of OAs in reducing OSA symptoms is achieved through the enlargement of the airways and reduction of snoring.[25]

The objective of this literature review is to update the knowledge and analyze the influence of RME and MAA in the treatment of OSA in children.

2. Materials and Methods

An electronic search was performed in PubMed, BVS, Cochrane Library, Scielo, ScienceDirect, Scopus and Google Scholar databases for studies published from January 2011 to November 2021. A highly sensitive search strategy was developed to identify studies of interest using the following keywords: "sleep apnea obstructive", "child", "adult children", "pediatric", "mandibular advancement", "palatal expansion". Additionally, “AND” and “OR” were used as Boolean operators. The following search formula was constructed for each of the databases using MeSH terms: "sleep apnea obstructive" AND "child" OR "adult children" OR "pediatric" AND "mandibular advancement" OR "palatal expansion". Systematic review and meta-analysis, prospective cohort study, literature review and clinical report all included in this review.

3. Results

A total of 170 articles were obtained from the electronic search and the references of the selected studies; and 16 articles discussed orthodontic applications and their relationship with OSA. Information about the authors/year of publication, the type of study, aim, and conclusions are summarized and depicted in Authors table **(Table 1).** Most of the studies focused on the decrease in the AHI after the use of OAs as a treatment for OSA.

Table 1. Authors table.

Authors	Year	Type of study	Type	Aim	Results
Machado et al.	2016	Systematic review and meta-analysis	RME	To evaluate RME in pediatric patients with obstructive sleep apnea syndrome.	RME in children appears to be an effective therapy for this syndrome. More randomized clinical trials are needed to determine the success of RME in adults.

Camacho et al.	2016	Systematic review and meta-analysis	RME	To determine data obtained from sleep study in pediatric patients with RME as therapy for OSA.	Improvement in AHI and decreased oxygen saturation have been analyzed in children undergoing RME, particularly in the short term.
Sanchez et al.	2019	Systematic review and meta-analysis	RME	To study the evidence on the results of RME in sleep apnea hypopnea syndrome, observing the variations in the oximetric variables.	RME would seem efficient for the treatment of mild or moderate hypopnea sleep apnea syndrome, as can be seen in the improvement of oximetric parameters; being efficient as an auxiliary treatment to adenotonsillectomy in severe cases of pediatric patients with maxillary compression.
Yanyan et al.	2019	Systematic review and meta-analysis	MAA	To determine the effect of MAA in pediatric patients with OSA.	MAA can be efficient for mild to severe patients before the end of the pubertal peak. Long-term therapy of at least six months turns out to be more efficient than short-term therapy.
Bahammam et al.	2020	Systematic review and meta-analysis	RME	To examine main findings on RME in the therapy of OSA.	The results showed that AHI improved after RME in pediatric patients with OSA.
Tabrizi et al.	2020	Systematic review and meta-analysis	RME and MAA	To analyze the efficacy of MAA and RME in the therapy of OSA in children.	The results obtained frequently showed that treatment with MAA and RME decreases OSA in pediatric patients.
Jeldez et al.	2020	Meta-analysis	RME	To clearly determine the effect of the use of maxillary expansion on the AHI.	It is not feasible to establish the result of the use of maxillary expansion on the AHI, effectiveness, sleep time, and micro arousals due to respiratory causes, because the existing evidence has been assessed as extremely low.

Droppelmann et al.	2021	Systematic review	RME and MAA	To detail the consequence of treatments for OSA in pediatric patients with sagittal or transverse intermaxillary anomalies.	There is not the necessary amount of evidence to conclude that these devices completely resolve the syndrome, but they reduce the AHI, its signs, and symptoms.
Nazaralli et al.	2015	Systematic review	MAA	To assess the effectiveness of MAAs for the therapy of pediatric OSA.	MAAs result in a short-term positive effect on AHI scores, but it is not possible to conclude that MAAs are effective in treating OSA in children.
Carvalho et al.	2016	Systematic review	MAA	To analyze the results of OAs for pediatric OSA.	In this study, a decrease of at least 50% in the AHI was considered. In 9 of the 14 treated subjects.
Koretsi et al.	2018	Systematic review	RME and MAA	To synthesize the existing evidence from randomized trials on the efficacy of OAs, RMEs, surgically assisted rapid maxillary expansion, and MAAs in the treatment of OSA.	OAs are effective in lowering the AHI and their use is supported by robust evidence. There is no high-quality research evidence to support therapy with maxillary expansion or MAA in patients with OSA.
Capalbo et al.	2021	Prospective cohort study	RME	To analyze polysomnographic data and quality of life before and after RME in patients diagnosed with OSA.	RME was efficient in OSA therapy considering the data obtained from PSG, improving the quality of life of pediatric patients.
Pirelli et al.	2015	Prospective study	RME	To prospectively assess the long-term effectiveness of RME in a group of pediatric patients with OSA.	A subgroup of OSA children with isolated maxillary narrowing initially and followed up into adulthood present stable, long-term

					results post RME treatment for pediatric OSA
Bariani et al.	2021	Literature review	MAA	To study the effects of OAs used to correct mandibular underdevelopment in OSA therapy.	All studies that used OAs for OSA in pediatric patients showed an improvement in the AHI score.
Galeotti et al.	2016	Clinical report	RME and MAA	Effects of simultaneous palatal expansion and mandibular advancement in a child suffering from OSA	Demonstrated an improvement of the main respiratory symptoms, while cardiorespiratory sleep study revealed a reduction in OSA events
Alexander et al.	2019	Case report	RME	RME followed by adenotonsillectomy was performed for the treatment of OSA.	An interdisciplinary treatment approach can yield dramatic improvement in sleep study findings and quality of life.

4. Literature review

4.1 Types of Apneas

Apnea is classified as central, obstructive, or mixed. In central apnea, air passage is absent due to insufficient respiratory effort.[29] In obstructive apnea, airflow is not present despite constant respiratory effort caused by upper airway obstruction.[29] In mixed apnea, central and obstructive apnea occur successively with no normal breathing between events.[29] It is important to emphasize that there are differences between pediatric OSA and OSA in adults; in children, it can cause behavioral problems, whereas in adults, they usually present daytime somnolence.[8]

4.2 Signs and symptoms

Resulting from enlarged tonsils and adenoids are some common signs like, maxillary compression, thin nasal cavity associated with a deep palate and posterior crossbite.[8,30] Similarly, an atypical orofacial growth pattern known as adenoid facies has been reported.[19]

OSA is associated with several daytime and nocturnal symptoms.[29] The diurnal ones involve exaggerated drowsiness and abnormal behavior such as aggressiveness, hyperactivity, or, in contrast, social isolation and pathological shyness; they present repetitive upper respiratory infections and headaches.[29] Regarding to nocturnal symptoms, it is observed that enuresis, nightmares, intense sweating, snoring, and episodes of apnea impede the normal sleep cycle and hinder its restorative function.[29,31] Fatal consequences can occur in the most severe cases of OSA due to cardiorespiratory failure caused by the disease.[15]

4.3 Apnea Hypopnea Index

AHI is the main aid diagnosis; it is defined as the number of apnea and hypopnea events recorded per hour of sleep.[15] The AHI is obtained by PSG examination and is based on the following criteria:

In adult none/minimal: AHI < 5 per hour; mild: AHI ≥ 5, but < 15 per hour; moderate: AHI ≥ 15, but < 30 per hour; severe: AHI ≥ 30 per hour.[32] In children none: AHI <1 per hour; mild: AHI 1–4 per hour, moderate: AHI 5–9 per hour, and severe: AHI ≥ 10 per hour.[9] The result of this index allows the severity of the symptoms and complications to be determined over time, in addition to guiding appropriate therapy for OSA.[30]

4.4 Diagnostic methods

The diagnosis of OSA is based on the data obtained from laboratory studies, physical examinations, and medical history.[11,29] The gold standard for the diagnosis of OSA is PSG,[28] which is made up by channels for electromyography, electroencephalography, electrocardiography, electrooculography, nasal and oral airflow, chest and abdominal movements, pulse oximetry, carbon dioxide tension, and arterial oxygen saturation.[14,29] PSG provides important data on some parameters related to sleep, including time spent below a certain level of oxygen saturation during the night, number and duration of complete or partial obstructions per hour of sleep, lowest oxygen saturation during each event, presence of arrhythmias, type of heart failure, presence and severity of respiratory disorders, and their impact on the cardiovascular system.[29] Data on the severity of sleep disruptions are also obtained.[29]

4.5 Continuous Positive Airway Pressure

The constant use of CPAP improves symptoms and can be evidenced by the improvement of PSG results in up to 85% of patients diagnosed with OSA. However, there are side effects that include blocked nose, dry mouth and increased number of awakenings.[33]

CPAP consists of using small machines that direct the insufflated air through air a tube and a mask that is placed over the nose or nose and mouth of the pediatric patient; the air is directed towards the back of the pharynx[33] with the aim of keeping the airway patent and to facilitate optimal breathing,[8] however, children have difficulties with adherence because they develop intolerance[15,26] and non-compliance.[34,35] Its use in pediatric patients is limited due to concerns associated with growth abnormalities[33] and the risk of developing maxillary retrognathia over time.[10,36] Some professionals have described the use of forehead supported masks to mitigate the negative effects of backward pressures on the face.[24]

OAs are often preferred over CPAP; however, treatment efficiency of OAs versus CPAP may result in the maintenance of residual OSA,[37] which is also manifested in CPAP therapy because many patients either reject treatment outright or only partially tolerate it, resulting in significant residual OSA.[38]

4.6 Surgical treatment

The aim of surgery is to widen the airway by removing the cause of its obstruction after determining exactly where it occurs.[39] The excess tissue is usually located in the oropharyngeal tract in patients with OSA.[39]

Adenotonsillectomy is not only used for children with OSA, it is also recommended for patients with adenotonsillar hypertrophy.[33] This is the main anatomical risk factor for OSA.[21] Adentonsillectomy has been shown to reduce the severity of OSA in most children as confirmed by polysomographic findings and quality of life changes.[21] Persistent residual OSA has been reported after surgery in between 25% and 40% of children treated with adenotonsillectomy.[33] Maxillary constriction, mandibular retrusion, a narrow upper airway and a long narrow face are craniofacial morphological characteristics often seen in children who coincidentally have OSA and enlarged tonsils.[21]

Uvulopalatopharyngoplasty is a surgical intervention which consists of the resection of uvula, part of the soft palate and tissue excess in the oropharynx, usually performed with simultaneous tonsillectomy.[39] This procedure can be assisted by laser or conventionally and is widely used as therapy for OSA in selected patients.[39]

Some long-term complications may include difficulty in swallowing, a dry throat and in up to a third of people treated presents velopharyngeal insufficiency.[39] Its success rate can vary, this depends on whether it is performed alone up to 30% and up to 60% if it is performed in conjunction with tonsillectomy.[39]

More extensive surgical approaches are used in craniofacial disorders where upper airway obstruction is severe.[40] Definitive surgical treatment for OSA is tracheotomy. Patients requiring this procedure often have neuromuscular disorders leading to hypotonia and severe craniofacial abnormalities.[40] This procedure may be used as a temporary measure to control severe OSA until another surgical procedure can be performed, although many pediatric patients remain tracheostomy-dependent.[40]

4.7 Oral Appliances

Over the last 10 years, oral appliances have gained increasing recognition as a useful alternative to CPAP.[39] OAs are common therapy for patients diagnosed with OSA.[39] It is essential to know the initial severity of OSA, which can influence[31] mainly in mild-to-moderate cases with non-compliance to CPAP, since CPAP seems to be more efficient in the definitive solution of OSA in relation to OAs.[6,41,42] There are several factors that contribute to therapeutic response to oral appliance treatment, including differences in devices and treatment protocols, as well as craniofacial and upper airway characteristics.[37]

4.8 Rapid maxillary expansion

Candidates for RME are patients with dental crowding, narrow palates or high arches, posterior crossbite, and class II and class III malocclusions.[43] Its objective is to expand the maxilla by separating the middle palatine suture, due to the late fusion that this structure presents.[43] Although this procedure is successfully performed in prepubertal patients, there is great variability in clinical results, mainly for late adolescent and young adult patients in whom this treatment is unpredictable.[43] This is because chronological age is not reliable in determining the developmental stage of the midpalatal suture during growth in these patients.[43]

Individual evaluation of midpalatal suture morphology prior to RME is important, Angelieri et al.[43] proposed a method of individual assessment of the midpalatal suture by cone beam computed tomography (CBCT).[43]

Probably, RME performed in patients in stage A where the midpalatal suture is almost a straight high-density sutural line with no or little interdigitation and in stage B, the midpalatal suture assumes an irregular shape and appears as a scalloped high-density line, where you would have less resisting forces and more skeletal effects than when performed during stage C in which the midpalatal suture appears as 2 parallel, scalloped, high-density lines that are close to each other, separated by small, low-density spaces in the maxillary and palatine bones.[43] On the other hand, it is important to highlight that, despite the greater sutural resistance to conventional RME in stage C, it is still possible to widen the maxilla orthopedically without surgical intervention. Stages A and B typically were observed up to 13 years of age, whereas stage C was noted primarily from 11 to 17 years but occasionally in younger and older age groups.[43]

Fastuca et al,[14] used an orthodontic appliance in the non-ossified mid-palatal joint to move the maxillary bones away through lateral pressure.[14] This results in the elimination of compression and increases the volume of the airway, allowing airflow,[44] this device causes expansion and flattening of the palatine arch with an inferior direction of the maxilla and a change in the alignment of the jaw.[45] During RME, there is a reduction in nasal resistance, which allows the passage of air through the nose and improves the respiratory condition.[45] RME increases the arch of the upper jaw, which favors the position of the tongue, provides the seal of the lips when the mouth is closed, and widens the oropharyngeal space, resulting in a significant reduction in oral breathing.[45]

In the study by Fastuca et al,[14] an increase of up to 45% in the transverse nasal area was observed after expansion. However, with these data and the V-shaped anatomy of the palate of the palatal suture, the increase in respiratory quality as the sole purpose of treatment is not considered an indication for RME.[14] Criteria that coincides with Eichenberger et al,[46] where they mention that in people with normal occlusion, RME is the last alternative to consider when other therapies have failed or have not given satisfactory results.[46]

Cabrera et al,[30] shows that there was a significant improvement in the living conditions of patients, regardless of the severity of their respiratory obstruction, as well as a decrease in the symptoms of OSA after RME therapy, as shown by the results of the PSG.[30] Similarly, Ashok et al,[47] in their research concluded that maxillary narrowing may be associated with chronic nasal obstruction and that RME has the objective of providing a key role in alleviating the obstruction.[47]

In a systematic review and meta-analysis by Camacho et al,[48] RME provides a 50% decrease in AHI, which produces an improvement in symptoms associated with pediatric OSA, mainly in a range of less than 3 years of follow-up. While the main findings in the study by Bahammam et al,[32] shows a 77% reduction in AHI compared to pre-and post-RME (from 12.05 ± 5.06 to 2.6 ± 1.96) with a follow-up of less than 3 years.[32] Whilst a follow-up equal to or greater than 3 years showed an improvement of 73% in the AHI comparing pre-and post-RME (from 8.46 ± 7.82 to 3.2 ± 2.62).[32]

Marklud et al,[49] discussed the efficiency of OAs over time and expressed that it is stable for up to 10 years, but the perspective is possibly reduced over time.[49] The progression of OSA usually causes deterioration of AHI.[49] Efficacy is affected and reduced because patients do not adhere to therapy due to insufficient subjective effects or potential side effects during OSA follow-up.[49] In contrast to a study by Pirelli et al,[50] whose objective was to prospectively evaluate the effectiveness of RME over time in a group of pediatric patients with OSA, where several clinical records of otorhinolaryngology, orthodontics, and scores of the questionnaires of each year were normal over time, as were PSG records over a 12-year follow-up period.[50]

In a systematic review and meta-analysis by Tabrizi et al,[51] in which AHI was used before and after RME therapy in the treatment of pediatric OSA, it was concluded that the mean difference was 6.37 events/ per hour (95% CI: 6.02-6.72) and showed statistically significant differences ($p=0.00$) before and after RME. Similar data were obtained in the study by Sanchez et al,[31] where the objective was to carry out a systematic review of the literature and a meta-analysis to analyze the result of the RME and determine its effects on the AHI, a mean reduction of 5.79 events/per hour.[31] Similar results were reported by Camacho et al.,[48] in which the data obtained from sleep analysis in pediatric patients who underwent RME for OSA as therapy, the AHI was reduced from 8.9 events/per hour to 2.7 events/per hour in a follow-up of less than 3 years.[48]

4.9 Mandibular advancement

For several years, mandibular advancement has been used to solve some types of malocclusion[52] as a therapy for pediatric OSA. Candidates for MAA are growing patients with Class II, Division 1 mandibular retrusion malocclusions that often reflect an imbalance or disharmony between the maxilla and mandible, typically with underdevelopment of the mandible and/or overdevelopment of the maxilla, which leading to a convex soft tissue profile.[53]

Its purpose is to modify the retrognathic mandibular position, redirecting its development towards a more frontal position.[28,53,54] In addition, it increases the size of the upper airway through OAs that come in different forms, such as orthopedic, orthodontic, removable, and fixed OAs, thereby reducing the risk factors for OSA.[13,,52,53]

Several studies suggest that there is stimulation of the dilator muscles of the upper airways to increase them; from an orthodontic point of view, they modify the neuromuscular forces in the craniofacial skeleton and dentition, causing a series of dentoalveolar and skeletal modifications.[18,25,29]

Growing patients who have a skeletal Class II jaw relationship, managed with OA's showed an increase in the upper airway dimensions and these changes remained even after cessation of facial growth.[30]

MAAs are an efficient therapeutic option for patients with mild-to-moderate OSA before the age of 13 years.[53] A treatment of at least 6 months before the end of the pubertal growth spurt is required for a noticeable and constant change in mandibular development, which may give better results than short-term treatment.[53]

In patients, the need for mandibular advancement depends on the degree of overjet.[52] Based on a review of the literature, mandibular advancement can vary from 3 to 7 mm. When the overjet is reduced, the measurement is recorded by locating the incisors in an edge-to-edge relationship; however, in a larger overjet, the incisor relationship will be recorded in two or three stages, bringing the mandible 4 mm forward in each stage, which creates more orthopedic variability and typically presents a positive change in airway permeability.[52]

Regarding the variation in the AHI, some studies have shown that regardless of the various treatments and procedures performed, there is a reduction in the AHI after therapy; thus, one study suggests that MAAs reduce the AHI,[52] with results similar to a systematic review by Carvalho et al,[29] where a single clinical trial reported a reduction of at least 50% in AHI in a total of 23 patients in which an acrylic resin oral bite plate for mandibular positioning was compared with a group without treatment.[29] Similar results were obtained in a systematic review by Nazaralli et al,[25] in which they suggested that MAAs show positive effects on AHI scores in a short period of time on AHI scores however, it is not possible to deduce that MAAs are efficient for the treatment of OSA in children.[25]

In another systematic review by Tabrizi et al,[51] where they used the following devices: Twin Block, Two acrylic plates, Herbst, and Modified monobloc, the effects on AHI were shown when mandibular advancement therapy was compared with a control group, with a mean of -1.79 events/per hour (95% CI: -2.10; -1.48) with a statistically significant difference (p=0.000) between the two studies and heterogeneity was I^2 = 46%, and there was no significant difference between groups (p=0.16), while the mean difference in AHI effects of MAA before and after OSA treatment in children was 1.84 events/ per hour (95% CI 1.60-2.07), showed a significant difference (p=0.000) in six studies and the heterogeneity between studies was statistically significant (p=0.000).[51] Similar results were reported by Yanyan et al,[53] who found the mean difference in AHI variation for the mandibular advancement group compared to the control group was -1.75 events/per hour (95% CI: -2 .07; -1.44) and showed a significant difference between the groups (p=0.00001).[53]

5. Conclusion

Orthopedic treatments for mild to moderate OSA include maxillary expansion using rapid maxillary expansion devices and mandibular advancement using mandibular advancement appliances, are both treatment options only for orthodontic (skeletal) reasons and should be applied after appropriate individual diagnosis for each orthodontic patient. Current limited evidence suggests that these therapies result in an improvement in the signs and symptoms of the condition as well as a decrease in AHI scores. However, it is not possible to conclude that these are effective in treating pediatric OSA, as there are few high-quality studies, mainly due to lack of control groups, small sample sizes, lack of randomization, and short-term results to support RME or MAA treatment in patients with OSA.

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