Sleep Medicine Reviews 25 (2016) 84–94

Contents lists available at ScienceDirect

Sleep Medicine Reviews

journal homepage: www.elsevier.com/locate/smrv

CLINICAL REVIEW

Orthodontics treatments for managing obstructive sleep apnea syndrome in children: A systematic review and meta-analysis

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ARTICLE INFO

Article history:
Received 4 August 2014
Received in revised form
6 February 2015
Accepted 9 February 2015
Available online 17 February 2015

Keywords:
Sleep-disordered breathing
Obstructive sleep apnea syndrome
Children
Young adolescents
Orthopedic mandibular advancement
Rapid maxillary expansion
Systematic review
Meta-analysis

SUMMARY

A small maxilla and/or mandible may predispose children to sleep-disordered breathing, which is a continuum of severity from snoring to obstructive sleep apnea. Preliminary studies have suggested that orthodontic treatments, such as orthopedic mandibular advancement or rapid maxillary expansion, may be effective treatments.

The aim is to investigate the efficacy of orthopedic mandibular advancement and/or rapid maxillary expansion in the treatment of pediatric obstructive sleep apnea. Pubmed, Medline, Embase, and Internet were searched for eligible studies published until April 2014. Articles with adequate data were selected for the meta-analysis; other articles were reported in the qualitative assessment. Data extraction was conducted by two independent authors. A total of 58 studies were identified. Only eight studies were included in the review; of these, six were included in the meta-analysis. The research yielded only a small number of studies. Consequently, any conclusions from the pooled diagnostic parameters and their interpretation should be treated carefully. Although the included studies were limited, these orthodontic treatments may be effective in managing pediatric snoring and obstructive sleep apnea. Other related health outcomes, such as neurocognitive and cardiovascular functions have not yet been systematically addressed. More studies are needed with larger sample size, specific inclusion and exclusion criteria and standardized data reporting to help establish guidelines for the orthodontic treatment of pediatric obstructive sleep apnea.

Introduction

Description of the condition

Craniofacial growth influenced by genetic inheritance and functional factors can have an impact on general health. Predominant mouth breathing, often caused by increased nasal breathing resistance or adenoid and tonsil hypertrophy, leads to altered muscle recruitment in the nasal and oral cavities, impacting craniofacial growth in a developing child [1,2] altering tongue position [3] and oropharyngeal volume, thereby increasing the risk of developing a significant malocclusion. In other words, a small maxilla and/or mandible may predispose children to sleep-disordered breathing (SDB), which is a continuum of severity from snoring to obstructive sleep apnea (OSA).

OSA is a breathing problem occurring during sleep; it is a common chronic disorder in children and adolescents, with a dramatic impact on systemic health [4] and development [5,6]. Among children and adolescents, the reported prevalence of snoring and OSA is 3–27% and 1–10%, respectively [7–11]. Snoring/OSA is a disorder of upper airway obstruction with multisystem implications and associated complications [11]. Snoring/OSA is often underdiagnosed in children and youth when the primary complaint is a behavioral problem. The American Academy of Sleep Medicine (AASM) states that other problems associated with untreated OSA in children include aggressive behavior [12], attention-deficit/hyperactivity disorder (ADHD) [13] and delays in development [14]. An 11-y longitudinal study on early childhood (4 y old) showed that early sleep problems predicted behavioral and emotional problems in adolescence [15]. If left untreated, OSA can

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http://dx.doi.org/10.1016/j.smrv.2015.02.002
1087-0792/

Abbreviations

AASM	American Academy of Sleep Medicine
ADHD	attention-deficit/hyperactivity disorder
AHI	apnea-hypopnea index
ANOVA	analysis of variance
ARRIVE	animal research: reporting in vivo experiments
CI	confidence interval
CONSORT	consolidated standards of reporting trials
ICC	intraclass correlation coefficient
NRCT	non-randomized controlled trial
OMA	orthopedic mandibular advancement
OSA	obstructive sleep apnea
OSAS	obstructive sleep apnea syndrome
PRISMA	preferred reported items for systematic reviews and meta-analyses
RCT	randomized controlled trial
RDI	respiratory disturbance index
RME	rapid maxillary expansion
SaO_2	oxygen saturation level
SDB	sleep-disordered breathing
SQ	sleep quality

negatively affect a child for the rest of his or her life. There are few proven treatments currently available, and most children are managed with tonsillectomy and adenoidectomy, which have not been demonstrated to fully abolish apnea in all patients, and/or positive airway pressure devices, which have a very poor compliance and are not ideal for all children [16–19]. Preliminary studies [1–3,15,20–23] have suggested that orthodontic treatments, such as maxillary expansion or mandibular advancement with functional appliances, may be effective in handling pediatric snoring and OSA. Accordingly, these preliminary results suggest that the correction of craniofacial structure imbalances during growth may reduce snoring and OSA in children and young adolescents.

Description of the interventions

This systematic review and meta-analysis focused on two main orthodontic interventions. The first intervention involves an orthopedic mandibular advancement (OMA) that aims to correct dental and skeletal retrognathia by re-directing mandibular growth into a more forward and downward position. This could potentially increase the opening of the oropharyngeal airway during wake and sleep. The second intervention involves rapid maxillary expansion (RME) which is used when the patient is diagnosed with a narrow upper jaw. RME decreases nasal resistance and allows tongue repositioning; as a result, it may reduce the risk of obstruction which contributes to sleep apnea. As a consequence, both interventions hold a probability of becoming valuable alternative treatments for patients who have known craniofacial risk factors, but who are not surgical candidates or are not able to tolerate the standard therapy for OSA or who failed either first-line treatments, i.e. adenotonsillectomy or nocturnal application of positive airway pressure.

How the interventions might work

Radiological studies indicate that a long and narrow face, a transverse deficiency, and retrognathia are craniofacial morphological factors associated with a narrow upper airway and SDB in children [24–27]. A recent study found that, compared to obesity, craniofacial morphology was a stronger risk factor for pediatric SDB [28]. Correction of craniofacial risk factors, with orthodontic treatments such as OMA and RME, in optimal conditions afforded by childhood growth may reduce snoring and OSA in children and young adolescents.

In 1860, RME therapy was first published as an orthodontic correction of maxillary constriction [29]. Thus, there is a great body of literature on RME in the fields of orthodontics and dental medicine. However, this therapy was first linked to SDB, when it was shown to decrease nocturnal enuresis in children, a sign and symptom associated to SDB [30–32]. RME is currently performed most often using a fixed intra-oral orthodontic appliance, which will be adjusted and worn at all times during the treatment. An expansion of 5–8 mm will be obtained over 30 d, with the expansion screw activated daily by parents (active phase). Following this active phase, the expansion screw will be locked into place for a retention phase of 2–6 mo to allow re-calcification of the palatine suture (retention phase).

OMA was first introduced by Dr Kingley with the "bite-jumping" appliance in 1879 [33]. The OMA encourages mandibular growth in a passive or active manner, while being fixed or removable (worn at night, from 21:00 h to 08:00 h). There are many different types of functional appliances, such as monobloc, activator, Frankel, Herbst, bionator and Twin-block [33]. Expected advancement will be of half cusp to full cusp (Class II; 3–6 mm). The mandibular advancement phase of OMA lasts up to 6–9 mo (depending on patient compliance with the removable appliance) followed by approximately 6 mo of retention. Moreover, some of the OMA appliances can be combined with RME appliances.

Why it is important to do this systematic review and meta-analysis

Following the *Pediatric Dental Sleep Apnea* strategic planning meeting in 2012 supported by the Canadian Institutes of Health Research, it was recognized that the level of evidence on orthodontic treatments to manage OSA is unknown. More specifically, the number and quality of non-randomized controlled trials (NRCT), and/or controlled before and after studies involving children and adolescents is undefined. There is a need to create a systematic review that includes meta-analysis components to synthesize the data from several studies. This estimation could overcome the barriers faced by clinicians [34] in applying evidence-based medicine and dentistry. To our knowledge, few systematic reviews and/or meta-analyses about craniofacial pediatric OSA have been published [11,35–39]. None has yet reviewed and synthesized the available orthodontic treatments for managing OSA in children and young adolescents (i.e. 18 y old or younger). Therefore, there is a need to create a systematic review and meta-analysis of all the available literature regarding orthodontic treatments, such as OMA and RME, for managing OSA in children and young adolescents.

Objectives

Our aims were to investigate the efficacy of the use of OMA (aim 1) and RME (aim 2) in the treatment of OSA in children and young adolescents.

Methods

Methods of analysis and inclusion criteria were specified in advance and documented in a protocol following Cochrane guidelines [40].

Electronic searches

For the identification of potential studies to include in the review and meta-analysis, detailed search strategies were developed for each