Topical Review: Sleep Bruxism, Headaches, and Sleep-Disordered Breathing in Children and Adolescents

Maria Clotilde Carra, DMD, PhD
Faculty of Dentistry
University of Montreal
Montreal, Quebec
Canada

Olivero Bruni, MD
Pediatric Sleep Center
Department of Developmental Neurology and Psychiatry
Sapienza University
Rome
Italy

Nelly Huynh, PhD
Faculty of Dentistry
University of Montreal
Montreal, Quebec
Canada

Correspondence to:
Dr Nelly Huynh
Faculté de Médecine Dentaire
Université de Montréal
CP 6128, succ. Centre-Ville
Montréal (QC) H3C 3J7
Canada
Email: nelly.huynh@umontreal.ca

Sleep bruxism, a well-known burden for dentists, is commonly observed in pediatric populations. Dentists are responsible for the detection and prevention of the detrimental consequences on the stomatognathic system that may occur in some patients with sleep bruxism. However, sleep bruxism is much more than tooth wear, since it is frequently associated with orofacial pain, headaches, and other more severe sleep disorders, such as sleep-disordered breathing. Although the mechanisms underlying the possible interactions among sleep bruxism, headaches, and sleep-disordered breathing need further research, these conditions are often concomitant. A literature search was performed to identify relevant publications related to the topic, which have been integrated in this topical review. The aim of this article was to provide a brief overview on sleep bruxism, headaches, and sleep-disordered breathing in pediatric patients and to promote a multispecialist approach (including dentists, sleep specialist physicians, and psychologists) in the diagnosis and management of these frequently associated disorders. J OROFAC PAIN 2012;26:267–276

Key words: headaches, orofacial pain, pediatrics, sleep bruxism, sleep-disordered breathing

Bruxism, a well-known burden for dentists, is commonly observed in pediatric populations. Dentists are responsible for the detection and prevention of its possible detrimental consequences on patients' oral health. However, bruxism is much more than tooth wear, showing frequent comorbidity with orofacial pain, headaches, and other more severe sleep disorders, such as sleep-disordered breathing. This review will focus on bruxism during sleep (sleep bruxism), discussing its possible relationship with headaches and sleep-disordered breathing in pediatric patients. In fact, a burgeoning amount of literature suggests important links, including possible causal relationships, between sleep bruxism, headaches, and sleep-disordered breathing. However, rarely has it been attempted to examine the complex interactions among all three conditions. Furthermore, in recent years, the importance of sleep physiology, sleep disorders, and their complications for dental practice has gathered more attention in the dental literature. The purpose of this review is to examine the current literature suggesting intimate connections between these seemingly disparate conditions, specifically from perspectives most relevant to dentistry, and to attempt to offer guidance on how dentists, as part of a multidisciplinary team of specialists, can most effectively address them.

Conditions

Sleep Bruxism

Sleep bruxism is a sleep-related movement disorder that is also classified as a parafunction in dentistry.[1,2] According to the International Classification of Sleep Disorders (ICSD-II),[2] sleep bruxism is an oral activity characterized by grinding and clenching of the teeth during sleep and is usually associated with sleep arousal. This sleep-related oral activity has the characteristics of a stereotyped movement known as rhythmic masticatory muscle activity (RMMA) of the masseter and temporalis muscles. RMMA can be demonstrated by electromyographic recordings performed during sleep.[3] Grinding sounds due to tooth contacts are the pathognomonic sign of sleep bruxism usually reported by patients, siblings, and parents. However, grinding noises do not occur during all RMMA/sleep bruxism episodes.

Typically, sleep bruxism is reported during childhood and adolescence, with an overall prevalence between 8% and 38%,[4–6] and tends to decrease after adulthood. This wide range in prevalence is because the majority of the epidemiologic studies have been based on self-report assessments of bruxism and most often failed to distinguish wake-time from sleep-related bruxism. Although they share some similarities, sleep bruxism and wake-time bruxism are considered two distinct conditions with likely different etiologies and physiopathologies.[3]

Although the etiology of sleep bruxism remains unknown, the physiopathology is partly explained by a reactivation of the cerebral and autonomic nervous systems during sleep (a process termed *sleep arousal*) that occurs in periods of sleep instability.[7–9] In addition, genetic factors and psychosocial components (such as anxiety and stress) seem to play a role in the complex mechanisms that regulate the occurrence of sleep bruxism.[10,11] However, further studies are necessary to understand better the physiopathology of sleep bruxism, especially to elucidate the etiologic factors that so far remain unknown. Sleep bruxism probably cannot be explained by a single cause, and causative factors are most likely variable between patients.

Although there is lack of data regarding the specific impact of sleep bruxism in pediatric populations, even young individuals with sleep bruxism seem to be more at risk for experiencing jaw muscle fatigue, reporting difficulties in wide opening of the jaw (ie, yawning), and perceiving an uncomfortable dental occlusion.[12] The presence or intensity of this muscle pain does not seem to be directly related to the frequency of RMMA/sleep bruxism episodes.[13] However, several studies have investigated sleep bruxism as a sign or cause of temporomandibular disorders (TMD), even in pediatric populations,[14,15] suggesting that sleep bruxism may have a role in the genesis of myogenous forms of TMD because of muscle hyperactivity during sleep. Nevertheless, TMD pain and sleep bruxism–related jaw muscle pain may be different entities; most patients with TMD report a peak in pain intensity in the afternoon and toward the evening, whereas sleep bruxism patients report transient masseter and temporalis muscle pain or soreness mainly in the morning.[13,16] Overall, there is a need for prospective and experimental trials to enable the identification of predisposing and risk factors for sleep bruxism in both pediatric and adult populations, since data currently available are based mainly on surveys and small case-control studies.

Sleep-Related Headaches

Headaches are a common problem in children, with as many as 70% of children being affected at least once during childhood.[17,18] Children with headaches usually have a high rate of sleep difficulties, such as insufficient sleep, insomnia, restless sleep, anxiety related to sleep, nightmares, or other parasomnias.[19,20] Several reports in the literature suggest a correlation and/or comorbidity between sleep disorders and headache, linked to common physiopathologic substrates.[21–23] The direction of this relationship is not clearly understood, but it is known that sleep is related to the occurrence of some headache syndromes and that headaches may cause various degrees of sleep disruption.[23,24] Headaches can occur during sleep, after sleep, and in relation to various sleep stages; moreover, an excess or lack of sleep and a bad quality or inadequate duration of sleep could cause headaches.[25,26] Nocturnal migraine attacks are typical effects of sleep disruption, while primary headaches may emerge during nocturnal sleep time and cause sleep disruptions.[23,24]

Different studies have proposed different models of interaction between headache and sleep, combining clinical data and experimental evidence (Table 1).[25,27] Clinically based studies have demonstrated that sleep, either spontaneous or induced by hypnotics, is efficacious to relieve head pain or even terminate attacks in both adults[28,29] and children[30] with headaches. The intrinsic mechanism that leads to head pain relief is still unknown and understudied; the hypothesis that sleep could trigger an autonomic reset seems to be the most reasonable.[31] However, the power of sleep in terminating the attack is somewhat counterbalanced by its ability to precipitate the attack. Although sleep was more commonly referred as a relieving factor for migraine

(70%), a migraine attack was also precipitated by sleep deprivation in 24% of cases and by sleep excess in 6% of cases.[32] Sleep is a precipitating factor for either nocturnal headache (awakening during a usual sleep period with a headache) or morning arousal with headache (headache present at arousal at the end of a behaviorally defined sleep period). Also, in a nonclinical pediatric population, a night of bad sleep was the most frequent triggering factor for headache complaints.[33]

A relationship between the sleep-wake cycle and the circadian aspects of headaches also seems to exist. Sleep in children with migraines does not usually differ from that of control subjects. However, sleep onset latency is slightly prolonged in migraine patients. The timing of migraine attacks may affect nocturnal motor activity. Indeed, sleep motor activities were shown to be lower on the night preceding the migraine attack, indicating a decrease in cortical activation during sleep preceding migraine attacks.[34] Another recent study has shown that the sleep quality of children with headaches is poor and that they complain more than children without headaches about experiencing excessive daytime sleepiness, spending less time in quiet-motionless sleep, and waking significantly earlier in the morning.[35]

Tension-type headache is another form of primary headache associated with sleep disturbances such as insomnia, hypersomnia, and circadian disorders.[21] Many of the patients presenting these conditions also have comorbid problems with anxiety, depression, and chronic pain.[36–38]

Table 1 Models of Interaction Between Sleep and Headache[25,27]

Sleep as trigger factor for headache (excessive, reduced, disrupted, or increased deep sleep)
Sleep disturbance as cause of headache (eg, sleep apnea)
Headache as cause of sleep disturbance (eg, headache attacks occuring during sleep)
Sleep disorders in headache patients (eg, parasomnias, sleep walking)
Sleep-related headache
Temporal relationship (during or after sleep)
Sleep stage relationship
REM sleep (migraine, cluster, chronic paroxysmal hemicrania)
Slow-wave sleep (migraine)
Headache/sleep association
Intrinsic orgin (modulation through the same neurotransmitters: eg, melatonin, serotonin)
Extrinsic orgin (ie, fibromyalgia syndrome)
Reinforcement (ie, bad sleep hygene)

Sleep-Disordered Breathing

Sleep-disordered breathing refers to a spectrum of disturbances that encompasses upper airway resistance, habitual snoring, and the more severe condition of obstructive sleep apnea. Sleep-disordered breathing occurs in children of all ages, from neonates to adolescents, and is characterized by repeated events of snoring and either partial (ie, hypopnea) or complete (ie, apnea) upper airway obstruction during sleep. Apnea and hypopnea may result in alterations of normal gas exchange, reductions in oxygen saturation levels, and disruption of sleep integrity.[39]

Habitual snoring during sleep is frequent during childhood, with up to 34% of children being affected.[40–43] Habitual snoring in children is already considered pathologic, and it is currently estimated that of the many children with habitual snoring, approximately 2% to 3% have clinically relevant obstructive sleep apnea.[44]

Obstructive sleep apnea is most common in young children (preschool and early school years), with a peak prevalence of around 2 to 8 years of age, which coincides with the peak in adenotonsillar hypertrophy relative to upper airway size.[45] It has been determined that the most frequent site of upper airway closure in children with obstructive sleep apnea is at the level of the tonsil and adenoids.[42] The greatest increase of tonsils and adenoids sizes takes place during the first few years of life, and this occurs proportionately with the growth of other upper airway structures.[46] Lymphadenoid tissue also proliferates more in children exposed to environmental irritants and cigarette smoke. Moreover, allergic rhinitis and asthma have been implicated in an increased prevalence of adenotonsillar hypertrophy and obstructive sleep apnea.[47] Other anatomical components, such as obesity and craniofacial morphology, and neuromuscular components that can contribute to narrowing the upper airway are also considered risk factors for sleep-disordered breathing development in children.[48]

Obese children are at increased risk for developing sleep-disordered breathing, and the severity of obstructive sleep apnea is proportional to the degree of obesity.[49,50] Obesity affects ventilation, particularly in the supine position, and causes upper airway narrowing due to fatty infiltration in pharyngeal structures and subcutaneous fat deposits at the neck level. Thus, two distinct phenotypes of obstructive sleep apnea patients have been identified in children: one is associated with marked lymphadenoid hypertrophy in the absence of obesity (type 1), while the other is

Table 2 Sleep Bruxism and Comorbidities
Parasomnias
Enuresis
Sleep talking
Sleep walking
Other sleep disorders
Sleep-disordered breathing (eg, snoring, obstructive sleep apnea)
Insomnia (eg, longer sleep latency, frequent awakenings)
Sleep-related epilepsy
Periodic limb movements
Medical and psychological conditions
Hypertrophic tonsils and adenoids
Allergies
Attention deficit hyperactivity disorder
Headaches
Orofacial pain and TMD
Anxiety
Separation anxiety at bedtime
Neurologic disorders
Medications
Methylphenidate (Ritalin)
SSRIs (paroxetine, fluoxetine, fluvoxamine, sertraline)
Antipsychotic (haloperidol)
Concomitant oral habits
Nail biting, pen biting, etc
Wake-time tooth clenching

SSRIs, selective serotonin reuptake inhibitors.

primarily associated with obesity in the presence of only mild lymphadenoid hyperplasia (type 2).[51]

Even in the absence of obesity, signs and symptoms of sleep-disordered breathing, such as mouth breathing, snoring, and daytime sleepiness, have been related to craniofacial morphologies, such as dolichofacial trait (ie, long face), maxillary transverse deficiency (ie, narrow palate), and retrognathia.[52–54] Whether sleep-disordered breathing is caused by abnormalities of the craniofacial structures, or abnormal craniofacial development is a result of functional limitations in the respiratory tracts, has not yet been established. In fact, craniofacial growth in children is determined by genetic factors, but is strongly influenced by environmental factors. As chronic mouth breathing is known to result in aberrant facial development, including maxillary constriction, chronic nasal or upper airway obstructions during sleep may influence the craniofacial growth that occurs mostly during sleep.[55,56]

The clinical syndrome of obstructive sleep apnea in children markedly differs from the typical obstructive sleep apnea seen in adults, in particular with respect to sex distribution, clinical manifestations, health consequences, and treatment approaches.[57,58] Pediatric obstructive sleep apnea can cause severe health consequences if not appropriately treated. It may lead to behavioral disturbances and learning deficits (often it is misdiagnosed as attention deficit hyperactivity disorder [ADHD]), cardiovascular morbidity, and metabolic disturbances.[59–61] Undiagnosed or untreated sleep-disordered breathing (especially obstructive sleep apnea) may also compromise somatic growth and decrease quality of life.[62,63] As such, it must be emphasized that sleep problems may interfere with a child's development, family, and social life.

Comorbidities and Risk Factors

Although the mechanisms underlying the possible interactions between sleep bruxism, headaches, and sleep-disordered breathing remain unknown, these conditions can be observed clinically as comorbidities in both pediatric and adult populations (Table 2). It can be hypothesized that sleep bruxism, reflected in repetitive rhythmic or sustained contractions of the masticatory muscles during sleep, may cause headaches during the day. However, the presence of an underlying sleep disorder, such as sleep-disordered breathing, can also be suspected since it is often associated with both sleep bruxism and headaches. In the latter case, the role of intermittent hypoxia and hypercapnia (and subsequent sleep fragmentation) may be the actual cause of headache (Fig 1). Alternatively, sleep bruxism, headache, and sleep-disordered breathing may share common risk factors or pathophysiologic substrates without a specific cause-effect relationship.[64,65]

Sleep Bruxism and Headaches

Different studies reported varying prevalences of orofacial pain in subjects with sleep bruxism that range from 66% to 84%.[66,67] In both adults and children, sleep bruxism has been associated with frequent headaches.[19,68,69] In particular, children with sleep bruxism may report approximately three times as many headaches than non–sleep bruxism subjects, with an odds ratio of 4.3.[12] However, a lack of correlation between TMD-type headache and the frequency of sleep bruxism activity was recently reported,[70] and the comorbidity between sleep bruxism and headache is sometimes controversial because of the overlap with forms of TMD pain.

Studies based on questionnaires in children showed an association between migraine headaches and sleep bruxism.[19,64] Sleep bruxism, other parasomnias (such as sleep talking and nightmares),

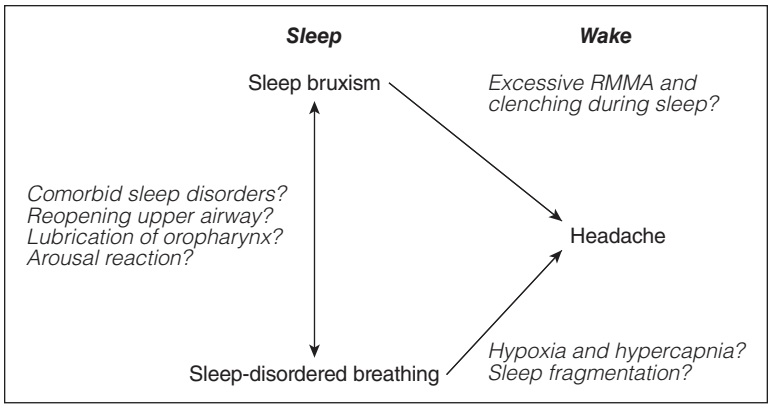

Fig 1 Putative mechanisms of comorbid sleep bruxism, headache, and sleep-disordered breathing.

and sleep-disordered breathing were also observed with greater frequency in children with migraines than control subjects.[19] More recently, it has been confirmed that children with migraines have a high rate of sleep disturbances, including sleep bruxism (29% prevalence).[20] Moreover, the frequency of migraine was a positive predictor of parasomnias, while the duration of migraine predicted sleep anxiety and bedtime resistance. In a polysomnographic study, 50% of children with tension-type headache manifested sleep bruxism versus 2.4% of children with nontension headaches.[68]

It is worth noting that frequent headaches in children may cause significant suffering and disability, create anxiety and disruption for parents and family members, and may present a reason for the child to stay home from school. Furthermore, headache can be a presenting symptom of several sleep disorders that could be therefore misdiagnosed: in several cases, a polysomnographic study may reveal the presence of a primary sleep disorder, and the treatment of the underlying clinical condition (sleep bruxism, periodic limb movements of sleep, fibromyalgia syndrome, and obstructive sleep apnea) may greatly improve the headache.[27] Therefore, a clinical assessment of headache complaints (questioning on pain characteristics, diet, sleep schedule, and sleep bruxism) and further diagnostic investigations are strongly recommended in children with sleep bruxism.

Sleep Bruxism and Sleep-Disordered Breathing

Sleep bruxism has frequently been associated with sleep-disordered breathing, in particular with snoring and obstructive sleep apnea.[71–74] As many as half of the children with sleep apnea also have sleep bruxism,[75,76] and two clinical open studies have demonstrated that the prevalence of sleep bruxism decreases after tonsillectomies or adenotonsillectomies in pediatric patients with sleep-disordered breathing.[75,77] Some evidence supports the hypothesis that sleep bruxism may help reinstate the airway patency following an obstructive respiratory event during sleep,[78] although this hypothesis needs further investigation.

Sleep-disordered breathing signs and symptoms, such as mouth breathing, snoring, and daytime sleepiness, have been also related to long-face morphology, maxillary transverse deficiency, and retrognathia.[52–54] Pediatric sleep bruxism subjects have been found to have a skeletal/dental Class II relationship at a frequency significantly higher than control subjects.[12] This retrognathic profile in sleep bruxism children may be seen as a predisposing factor for sleep-disordered breathing.

Sleep bruxism has been described, especially in children, in relation to behavioral problems (ie, hyperactivity, attention deficit, sleepiness, poor school performance), with a frequent comorbidity with ADHD.[79,80] These ADHD-like behaviors could also be the manifestation of specific psychosocial factors or personality traits that seem to be related to bruxism in children and adolescents.[81,82] However, sleep bruxism in ADHD patients has also been described as an adverse effect of ADHD treatment, usually with amphetamine-like medications (eg, methylphenidate).[83] In these cases, the term secondary sleep bruxism is often used. Moreover, ADHD patients frequently show concomitant sleep problems, such as poor sleep quality, snoring, sleep apnea, sleepiness, insomnia, other parasomnias, and sleep-related movement disorders.[84,85] ADHD is often misdiagnosed, and underlying sleep respiratory disorders, such as sleep-disordered breathing, are the main causes of the daytime behavioral problems.[86]

Sleep-Disordered Breathing and Headaches

Sleep-disordered breathing and obstructive sleep apnea may be frequent causes of headaches since 30% to 70% of obstructive sleep apnea patients

Table 3 Symptoms of Sleep-Disordered Breathing in Children and Adolescents[60,61]

Nightime	Daytime
Chronic, heavy snoring	Morning tension-type headache
Difficutly breathing during sleep	Mouth breathing
Witnessed breathing pauses during sleep	Escessive fatigue and sleepiness
Mouth breathing	Excessive morning thrist
Restless sleep	Abnormal shyness, withdrawn and depressive presentation
Periodic limb movement	
Delayed sleep onset	Behavioral problems
Insomnia	Pattern of ADHD
Frequent awakenings	Aggresiveness
Nocturnal migraine	Irritability
Abnormal sleeping positions	Poor concentration
Drooling	Learning difficulties
Sleep talking	Memory impairment
Sleep walking	Poor academic performance
Nocturnal sweating	
Enuresis	
Difficulty waking up in the morning	
Confused arousal	

suffer from headaches.[27,87,88] In a recent study of 90 children with headaches, it was shown that sleep-disordered breathing was more frequent in children with migraine (56.6%) and nonspecific headache (54%) than chronic migraine (27%).[68] Data on a particular form of headache, cluster headache, revealed that obstructive sleep apnea can trigger cluster headache attacks. Furthermore, cluster headache has been reported as an associated disorder of obstructive sleep apnea with a comorbidity between 31% and 80%.[89]

Although this head pain in obstructive sleep apnea patients seems to be a nonspecific symptom,[88] the types of headache in obstructive sleep apnea have mainly features of tension-type headache, migraine, or chronic migraine,[90] often reported in the morning. The physiopathology of morning headache in obstructive sleep apnea patients is not clearly understood: The role of nocturnal hypoxemia is controversial, and few relationships have been found with sleep architectural parameters. However, it is possible that headache is the consequence of the repetitive obstructive respiratory events associated with oxygen desaturation and sleep fragmentation (see Fig 1). As indirect evidence, treatment of obstructive sleep apnea with continuous positive airway pressure (CPAP) devices appears to improve or resolve headache in a subset of patients.[91] This explanation requires further study using specific electrophysiologic recordings and breathing monitoring during sleep to be confirmed.

A Multispecialist Approach

Screening and Diagnosis

Sleep bruxism is normally reported to dentists by the patient and/or parents. The diagnosis of sleep bruxism is usually clinical, based on the presence of the following signs and symptoms: abnormal tooth wear, hypertrophy of masseter and/or temporalis muscles, fatigue, discomfort or pain in the jaw muscles. Reports of tooth grinding sounds by patients or parents are also an important diagnostic criterion.[3] Moreover, the presence of TMD, orofacial pain, and headache need to be assessed in patients with sleep bruxism.

Although a variety of tools have been developed to assess jaw muscle activity during sleep, the gold standard for sleep bruxism diagnosis remains a full-night polysomnographic (PSG) audio-video recording, which allows the simultaneous monitoring of sleep electroencephalographic, electrocardiographic, electromyographic, and respiratory signals during sleep. However, PSG recordings are not routinely performed for sleep bruxism diagnosis, as they are both costly and time-consuming. A PSG investigation may be indicated in cases of sleep bruxism associated with other signs and symptoms suggestive of other sleep disorders, especially sleep-disordered breathing. In these cases, the patient has to be referred to a sleep specialist for further investigations and diagnosis.

The diagnosis of sleep-disordered breathing—a medical diagnosis—can be made by only a physician. However, dentists may have a very important role in the screening process, identifying features suggestive of sleep-disordered breathing during their clinical evaluations (Table 3). Most of the time, the lack of easily recognizable respiratory symptoms during sleep may lead to delays in diagnosis and treatment of sleep-disordered breathing, particularly if daytime symptoms are mild or misattributed to other causes. Dentists can recognize early risk factors and promote further investigations when necessary. A good clinical history and a physical examination of the oropharyngeal structures (eg, palatal height, tongue size, tonsil size, and Mallampati score[92]) represent the standard screening approach.[93] Dentists can ask questions during the clinical examination or use specific questionnaires to investigate sleep quality, sleepiness, headache, and other symptoms. Several questionnaires have been validated for clinical and research purposes in children with suspected sleep-disordered breathing, such as the Pediatric Sleep Questionnaire, the Sleep Disturbance Scale for Children, the OSA-18, and the modified version for children of the Epworth Sleepiness Scale.[94] Other

questionnaires on general health and quality of life can also be added.

When screening children with sleep-disordered breathing, it is also very important to question parents or guardians and sometimes siblings who may accompany the child and who are often more aware of the child's complaints and habits. However, it is worth noting that clinical history and questionnaires do not reliably distinguish between primary snoring and obstructive sleep apnea and do not assess the severity of sleep-disordered breathing. Thus, they have to be considered only valuable screening tools. Once signs and symptoms suggestive of sleep-disordered breathing are present, the patient should be referred to a sleep specialist for further diagnostic investigations (usually a PSG evaluation).

Headache complaints can be investigated by directly questioning the patient or his or her parents during the clinical examination or by using specific questionnaires. It is important to evaluate the sleep schedule, diet, familiarity (do the parents also suffer from headaches?), type and intensity of pain, and onset and duration of headache-pain attacks. A headache diary can be kept for a few weeks to monitor the frequency and variations of headache. However, the exact diagnosis of the type of headache relies on a neurologic examination that should be advised if the headache complaint considerably influences the normal functioning and the family and social life of the patient.

Treatments

Currently, no therapy has been proven to be effective in treating sleep bruxism in children. The available treatment approaches have shown different levels of efficacy in managing the potentially harmful consequences of sleep bruxism.[95] In children, after the exclusion of comorbidities (eg, sleep apnea, allergies, use of psychoactive medication such as methylphenidate, stress-related factors, and neurologic conditions), sleep bruxism may be considered a physiologic oral parafunction that just needs to be followed up over time.

When aggravated symptoms, subsequent complaints, and damage of orofacial structures are present, conservative therapies should be preferred. These include behavioral modifications, biofeedback, sleep hygiene, and familial counseling on sleep habits. In addition, in the most severe cases, temporary occlusal splints that need a strict follow-up in pediatric patients could be used to protect dental surfaces from tooth wear.[96]

The application of sleep hygiene guidelines could also help in managing headaches in children with inappropriate sleep behavior, without resorting to pharmacologic treatments. It has been shown that the frequency and duration of migraine attacks may be sensitive to the modification of the sleep habits, while the severity was more related to the alteration of the structure of sleep.[97] Some studies have supported the role of melatonin (hormone that regulates the circadian rhythm) as an effective preventive therapy in primary headaches and migraines in both adults[98] and children.[99]

For pediatric sleep-disordered breathing, the first-line treatment in children is often adenotonsillectomy.[100] However, this does not guarantee a complete resolution of the disorder in all patients. Combined treatments (ie, adenotonsillectomy and orthodontic palatal expansion) are often necessary, and long-term follow-up is strongly recommended in these patients.[101] Other treatment approaches are orthodontic and surgical therapies to correct abnormal craniofacial morphologies, CPAP during sleep, or medical therapies for nasal obstruction and allergies (ie, anti-inflammatory medications).[102]

Children with comorbid sleep bruxism, sleep-disordered breathing, and headache must be correctly diagnosed and strictly followed up over time. The identification of the primary disorder and the management of the concomitant conditions usually need combined approaches. In many cases, the resolution of the driven pathology (eg, sleep-disordered breathing) may lead to the resolution or improvement of the other consequent signs and symptoms (eg, headaches and sleep bruxism).[75] However, this is not observed in all patients, and a multispecialist approach is often recommended also in the treatment of comorbid sleep bruxism, sleep-disordered breathing, and headache.

Conclusions

In most pediatric cases of sleep bruxism, it is an oral parafunction that simply needs to be followed over time. However, this oral activity is nonetheless frequently reported in association with daytime symptoms, such as headache, and as other sleep disorders, including sleep-disordered breathing. The exact relationship among sleep bruxism, headache, and sleep-disordered breathing remains unclear, and more prospective and experimental studies are needed to explore the putative pathogenetic mechanisms that may underlie these conditions. However, dentists are in a privileged position to screen patients with sleep bruxism and identify risk factors for headache and sleep-disordered breathing during their dental visits, since they see more than 85% of

the pediatric population at least once a year.[103] The patient at risk should be referred to other specialists (ie, sleep medicine physicians, otolaryngologists, and psychologists) to assess possible comorbidities, perform an early diagnosis, and identify the best therapeutic approach. Once the diagnosis is given, dentists may once again be involved in the management process of sleep bruxism, headache, and sleep-disordered breathing, providing oral appliances and orthodontic treatment. For these reasons, the best and most effective approach seems to be a team approach, where multispecialist competences are integrated and implemented for the best level of care for the patient.

Acknowledgments

Maria Clotilde Carra received a scholarship from the Ministère de l'Éducation, du Loisir et du Sport du Quebec. Olivero Bruni and Nelly Huynh indicated no financial conflicts of interest.

References

1. The glossary of prosthodontic terms. J Prosthet Dent 2005; 94:10–92.
2. Sleep related bruxism in: American Academy of Sleep Medicine (AASM) (eds). ICSD-2 International Classification of Sleep Disorders, ed 2. Diagnosis and Coding Manual. Westchester, IL: AASM, 2005:189–192.
3. Lavigne G, Manzini C, Huynh NT. Sleep bruxism. In: Kryger MH, Roth T, Dement WC (eds). Principles and Practice of Sleep Medicine. St Louis: Elsevier Saunders, 2011: 1129–1139.
4. Simola P, Niskakangas M, Liukkonen K, et al. Sleep problems and daytime tiredness in Finnish preschool-aged children—A community survey. Child Care Health Dev 2010; 36:805–811.
5. Petit D, Touchette E, Tremblay RE, Boivin M, Montplaisir J. Dyssomnias and parasomnias in early childhood. Pediatrics 2007;119:e1016–e1025.
6. Cheifetz AT, Osganian SK, Allred EN, Needleman HL. Prevalence of bruxism and associated correlates in children as reported by parents. J Dent Child (Chic) 2005;72:67–73.
7. Lavigne G, Toumilehto H, Macaluso GM. Pathophysiology of sleep bruxism. In: Lavigne GJ, Cistulli PA, Smith MT (eds). Sleep Medicine For Dentists: A Practical Overview. Chicago: Quintessence, 2009:117–124.
8. Lavigne GJ, Huynh N, Kato T, et al. Genesis of sleep bruxism: Motor and autonomic-cardiac interactions. Arch Oral Biol 2007;52:381–384.
9. Carra MC, Rompre PH, Kato T, et al. Sleep bruxism and sleep arousal: An experimental challenge to assess the role of cyclic alternating pattern. J Oral Rehabil 2011;38:635–642.
10. Hublin C, Kaprio J. Genetic aspects and genetic epidemiology of parasomnias. Sleep Med Rev 2003;7:413–421.
11. Manfredini D, Lobbezoo F. Role of psychosocial factors in the etiology of bruxism. J Orofac Pain 2009;23:153–166.
12. Carra MC, Huynh N, Morton P, et al. Prevalence and risk factors of sleep bruxism and wake-time tooth clenching in a 7- to 17-year-old population. Eur J Oral Sci 2011;119: 386–394.
13. Rompre PH, Daigle-Landry D, Guitard F, Montplaisir JY, Lavigne GJ. Identification of a sleep bruxism subgroup with a higher risk of pain. J Dent Res 2007;86:837–842.
14. Pereira LJ, Pereira-Cenci T, Del Bel Cury AA, et al. Risk indicators of temporomandibular disorder incidences in early adolescence. Pediatr Dent 2010;32:324–328.
15. Nilsson IM, List T, Drangsholt M. Incidence and temporal patterns of temporomandibular disorder pain among Swedish adolescents. J Orofac Pain 2007;21:127–132.
16. Dao TT, Lund JP, Lavigne GJ. Comparison of pain and quality of life in bruxers and patients with myofascial pain of the masticatory muscles. J Orofac Pain 1994;8:350–356.
17. Laurell K, Larsson B, Eeg-Olofsson O. Prevalence of headache in Swedish schoolchildren, with a focus on tension-type headache. Cephalalgia 2004;24:380–388.
18. Zwart JA, Dyb G, Holmen TL, Stovner LJ, Sand T. The prevalence of migraine and tension-type headaches among adolescents in Norway. The Nord-Trondelag Health Study (Head-HUNT-Youth), a large population-based epidemiological study. Cephalalgia 2004;24:373–379.
19. Bruni O, Fabrizi P, Ottaviano S, Cortesi F, Giannotti F, Guidetti V. Prevalence of sleep disorders in childhood and adolescence with headache: A case-control study. Cephalalgia 1997;17:492–498.
20. Miller VA, Palermo TM, Powers SW, Scher MS, Hershey AD. Migraine headaches and sleep disturbances in children. Headache 2003;43:362–368.
21. Aguggia M, Cavallini M, Divito N, et al. Sleep and primary headaches. Neurol Sci 2011;32:51–54.
22. Bruni O, Novelli L, Guidetti V, Ferri R. Sleep and headaches during adolescence. Adolesc Med State Art Rev 2010;21:446–456.
23. Alberti A. Headache and sleep. Sleep Med Rev 2006;10: 431–437.
24. Dodick DW, Eross EJ, Parish JM, Silber M. Clinical, anatomical, and physiologic relationship between sleep and headache. Headache 2003;43:282–292.
25. Sahota PK, Dexter JD. Sleep and headache syndromes: A clinical review. Headache 1990;30:80–84.
26. Jennum P, Jensen R. Sleep and headache. Sleep Med Rev 2002;6:471–479.
27. Paiva T, Batista A, Martins P, Martins A. The relationship between headaches and sleep disturbances. Headache 1995;35:590–596.
28. Wilkinson M, Williams K, Leyton M. Observations on the treatment of an acute attack of migraine. Res Clin Stud Headache 1978;6:141–146.
29. Blau JN. Resolution of migraine attacks: Sleep and the recovery phase. J Neurol Neurosurg Psychiatry 1982;45: 223–226.
30. Aaltonen K, Hamalainen ML, Hoppu K. Migraine attacks and sleep in children. Cephalalgia 2000;20:580–584.
31. Dexter JD. Relationship between sleep and headache syndromes. In: Thorpy MJ (ed). Handbook of Sleep Disorders. New York: Marcel Dekker, 1990:663–671.
32. Inamorato E, Minatti-Hannuch SN, Zukerman E. The role of sleep in migraine attacks. Arq Neuropsiquiatr 1993; 51:429–432.
33. Bruni O, Russo PM, Ferri R, Novelli L, Galli F, Guidetti V. Relationships between headache and sleep in a non-clinical population of children and adolescents. Sleep Med 2008;9:542–548.

34. Bruni O, Russo PM, Violani C, Guidetti V. Sleep and migraine: An actigraphic study. Cephalalgia 2004;24:134–139.
35. Bursztein C, Steinberg T, Sadeh A. Sleep, sleepiness, and behavior problems in children with headache. J Child Neurol 2006;21:1012–1019.
36. Ong JC, Stepanski EJ, Gramling SE. Pain coping strategies for tension-type headache: Possible implications for insomnia? J Clin Sleep Med 2009;5:52–56.
37. Anttila P, Metsahonkala L, Aromaa M, et al. Determinants of tension-type headache in children. Cephalalgia 2002;22:401–408.
38. Fumal A, Schoenen J. Tension-type headache: Current research and clinical management. Lancet Neurol 2008; 7:70–83.
39. Chan ASL, Lee RWW, Cistulli PA. Sleep-related breathing disorders. In: Lavigne GJ, Cistulli PA, Smith MT (eds). Sleep Medicine For Dentists: A Practical Overview. Chicago: Quintessence, 2009:35–40.
40. Brunetti L, Rana S, Lospalluti ML, et al. Prevalence of obstructive sleep apnea syndrome in a cohort of 1,207 children of southern Italy. Chest 2001;120:1930–1935.
41. Lumeng JC, Chervin RD. Epidemiology of pediatric obstructive sleep apnea. Proc Am Thorac Soc 2008;5:242–252.
42. Bixler EO, Vgontzas AN, Lin HM, et al. Sleep disordered breathing in children in a general population sample: Prevalence and risk factors. Sleep 2009;32:731–736.
43. Castronovo V, Zucconi M, Nosetti L, et al. Prevalence of habitual snoring and sleep-disordered breathing in preschool-aged children in an Italian community. J Pediatr 2003;142:377–382.
44. Tang JP, Rosen CL, Larkin EK, et al. Identification of sleep-disordered breathing in children: Variation with event definition. Sleep 2002;25:72–79.
45. Marcus CL. Sleep-disordered breathing in children. Am J Respir Crit Care Med 2001;164:16–30.
46. Arens R, Marcus CL. Pathophysiology of upper airway obstruction: A developmental perspective. Sleep 2004;27: 997–1019.
47. Muliol J, Maurer M, Bousquet J. Sleep and allergic rhinitis. J Investig Allergol Clin Immunol 2008;18:415–419.
48. Katz ES, D'Ambrosio CM. Pediatric obstructive sleep apnea syndrome. Clin Chest Med 2010;31:221–234.
49. Kohler MJ, Thormaehlen S, Kennedy JD, et al. Differences in the association between obesity and obstructive sleep apnea among children and adolescents. J Clin Sleep Med 2009;5:506–511.
50. Lam YY, Chan EY, Ng DK, et al. The correlation among obesity, apnea-hypopnea index, and tonsil size in children. Chest 2006;130:1751–1756.
51. Dayyat E, Kheirandish-Gozal L, Gozal D. Childhood obstructive sleep apnea: One or two distinct disease entities? Sleep Med Clin 2007;2:433–444.
52. Pirila-Parkkinen K, Pirttiniemi P, Nieminen P, Tolonen U, Pelttari U, Lopponen H. Dental arch morphology in children with sleep-disordered breathing. Eur J Orthod 2009; 31:160–167.
53. Tsuda H, Fastlicht S, Almeida FR, Lowe AA. The correlation between craniofacial morphology and sleep-disordered breathing in children in an undergraduate orthodontic clinic. Sleep Breath 2011;15:163–171.
54. Huynh NT, Morton PD, Rompre PH, Papadakis A, Remise C. Associations between sleep-disordered breathing symptoms and facial and dental morphometry, assessed with screening examinations. Am J Orthod Dentofacial Orthop 2011;140:762–770.
55. Peltomaki T. The effect of mode of breathing on craniofacial growth—revisited. Eur J Orthod 2007;29:426–429.
56. Harari D, Redlich M, Miri S, Hamud T, Gross M. The effect of mouth breathing versus nasal breathing on dentofacial and craniofacial development in orthodontic patients. Laryngoscope 2010;120:2089-2093.
57. Guilleminault C, Lee JH, Chan A. Pediatric obstructive sleep apnea syndrome. Arch Pediatr Adolesc Med 2005;159: 775–785.
58. Gozal D, O'Brien L, Row BW. Consequences of snoring and sleep disordered breathing in children. Pediatr Pulmonol Suppl 2004;26:166–168.
59. Beebe DW. Neurobehavioral morbidity associated with disordered breathing during sleep in children: A comprehensive review. Sleep 2006;29:1115–1134.
60. Gozal D, Kheirandish-Gozal L, Bhattacharjee R, Spruyt K. Neurocognitive and endothelial dysfunction in children with obstructive sleep apnea. Pediatrics 2010;126:e1161–e1167.
61. Chervin RD, Archbold KH, Dillon JE, et al. Inattention, hyperactivity, and symptoms of sleep-disordered breathing. Pediatrics 2002;109:449–456.
62. Montgomery-Downs HE, Young ME, Ross MA, Polak MJ, Ritchie SK, Lynch SK. Sleep-disordered breathing symptoms frequency and growth among prematurely born infants. Sleep Med 2010;11:263–267.
63. Kiris M, Muderris T, Celebi S, Cankaya H, Bercin S. Changes in serum IGF-1 and IGFBP-3 levels and growth in children following adenoidectomy, tonsillectomy, or adenotonsillectomy. Int J Pediatr Otorhinolaryngol 2010;74:528–531.
64. Isik U, Ersu RH, Ay P, et al. Prevalence of headache and its association with sleep disorders in children. Pediatr Neurol 2007;36:146–151.
65. Liljestrom MR, Le Bell Y, Anttila P, et al. Headache children with temporomandibular disorders have several types of pain and other symptoms. Cephalalgia 2005;25: 1054–1060.
66. Bader G, Lavigne G. Sleep bruxism; An overview of an oromandibular sleep movement disorder. Review article. Sleep Med Rev 2000;4:27–43.
67. Camparis CM, Siqueira JT. Sleep bruxism: Clinical aspects and characteristics in patients with and without chronic orofacial pain. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;101:188–193.
68. Vendrame M, Kaleyias J, Valencia I, Legido A, Kothare SV. Polysomnographic findings in children with headaches. Pediatr Neurol 2008;39:6–11.
69. Lavigne G, Palla S. Transient morning headache: Recognizing the role of sleep bruxism and sleep-disordered breathing. J Am Dent Assoc 2010;141:297–299.
70. Nagamatsu-Sakaguchi C, Minakuchi H, Clark GT, Kuboki T. Relationship between the frequency of sleep bruxism and the prevalence of signs and symptoms of temporomandibular disorders in an adolescent population. Int J Prosthodont 2008;21:292–298.
71. Sheldon SH. Obstructive sleep apnea and bruxism in children. In: Clinics SM (ed). Dentistry's Role in Sleep Medicine. Philadelphia: Saunders, 2010:163–168.
72. Eitner S, Urschitz MS, Guenther A, et al. Sleep problems and daytime somnolence in a German population-based sample of snoring school-aged children. J Sleep Res 2007;16: 96–101.
73. Grechi TH, Trawitzki LV, de Felicio CM, Valera FC, Alnselmo-Lima WT. Bruxism in children with nasal obstruction. Int J Pediatr Otorhinolaryngol 2008;72:391–396.
74. Ohayon MM, Li KK, Guilleminault C. Risk factors for sleep bruxism in the general population. Chest 2001;119:53–61.

75. DiFrancesco RC, Junqueira PA, Trezza PM, de Faria ME, Frizzarini R, Zerati FE. Improvement of bruxism after T & A surgery. Int J Pediatr Otorhinolaryngol 2004;68: 441–445.
76. Gregorio PB, Athanazio RA, Bitencourt AG, Neves FB, Terse R, Hora F. Symptoms of obstructive sleep apnea-hypopnea syndrome in children [in Portuguese]. J Bras Pneumol 2008;34:356–361.
77. Eftekharian A, Raad N, Gholami-Ghasri N. Bruxism and adenotonsillectomy. Int J Pediatr Otorhinolaryngol 2008;72:509–511.
78. Khoury S, Rouleau GA, Rompre PH, Mayer P, Montplaisir JY, Lavigne GJ. A significant increase in breathing amplitude precedes sleep bruxism. Chest 2008;134:332–337.
79. Silvestri R, Gagliano A, Arico I, et al. Sleep disorders in children with attention-deficit/hyperactivity disorder (ADHD) recorded overnight by video-polysomnography. Sleep Med 2009;10:1132–1138.
80. Herrera M, Valencia I, Grant M, Metroka D, Chialastri A, Kothare SV. Bruxism in children: Effect on sleep architecture and daytime cognitive performance and behavior. Sleep 2006;29:1143–1148.
81. Restrepo CC, Vasquez LM, Alvarez M, Valencia I. Personality traits and temporomandibular disorders in a group of children with bruxing behaviour. J Oral Rehabil 2008;35:585–593.
82. Serra-Negra JM, Ramos-Jorge ML, Flores-Mendoza CE, Paiva SM, Pordeus IA. Influence of psychosocial factors on the development of sleep bruxism among children. Int J Paediatr Dent 2009;19:309–317.
83. Malki GA, Zawawi KH, Melis M, Hughes CV. Prevalence of bruxism in children receiving treatment for attention deficit hyperactivity disorder: A pilot study. J Clin Pediatr Dent 2004;29:63–67.
84. LeBourgeois MK, Avis K, Mixon M, Olmi J, Harsh J. Snoring, sleep quality, and sleepiness across attention-deficit/hyperactivity disorder subtypes. Sleep 2004;27:520–525.
85. Walters AS, Silvestri R, Zucconi M, Chandrashekariah R, Konofal E. Review of the possible relationship and hypothetical links between attention deficit hyperactivity disorder (ADHD) and the simple sleep related movement disorders, parasomnias, hypersomnias, and circadian rhythm disorders. J Clin Sleep Med 2008;4:591–600.
86. Owens JA. A clinical overview of sleep and attention-deficit/hyperactivity disorder in children and adolescents. J Can Acad Child Adolesc Psychiatry 2009;18:92–102.
87. Kudrow L, McGinty DJ, Phillips ER, Stevenson M. Sleep apnea in cluster headache. Cephalalgia 1984;4:33–38.
88. Neau JP, Paquereau J, Bailbe M, Meurice JC, Ingrand P, Gil R. Relationship between sleep apnoea syndrome, snoring and headaches. Cephalalgia 2002;22:333–339.
89. Chervin RD, Zallek SN, Lin X, Hall JM, Sharma N, Hedger KM. Sleep disordered breathing in patients with cluster headache. Neurology 2000;54:2302–2306.
90. Mitsikostas DD, Viskos A, Papadopoulos D. Sleep and headache: The clinical relationship. Headache 2010;50: 1233–1245.
91. Goksan B, Gunduz A, Karadeniz D, et al. Morning headache in sleep apnoea: Clinical and polysomnographic evaluation and response to nasal continuous positive airway pressure. Cephalalgia 2009;29:635–641.
92. Nuckton TJ, Glidden DV, Browner WS, Claman DM. Physical examination: Mallampati score as an independent predictor of obstructive sleep apnea. Sleep 2006;29:903–908.
93. Lee RWW, Chan ASL, Cistulli PA. Clinical approach to diagnosis of obstructive sleep apnea. In: Lavigne GJ, Cistulli PA, Smith MT (eds). Sleep Medicine For Dentists: A Practical Overview. Chicago: Quintessence, 2009:53–59.
94. Chervin RD, Hedger K, Dillon JE, Pituch KJ. Pediatric sleep questionnaire (PSQ): Validity and reliability of scales for sleep-disordered breathing, snoring, sleepiness, and behavioral problems. Sleep Med 2000;1:21–32.
95. Huynh N, Manzini C, Rompre PH, Lavigne GJ. Weighing the potential effectiveness of various treatments for sleep bruxism. J Can Dent Assoc 2007;73:727–730.
96. Huynh N, Guilleminault C. Sleep bruxism in children. In: Lavigne GJ, Cistulli PA, Smith MT (eds). Sleep Medicine For Dentists: A Practical Overview. Chicago: Quintessence, 2009:125–131.
97. Bruni O, Galli F, Guidetti V. Sleep hygiene and migraine in children and adolescents. Cephalalgia 1999;25:57–59.
98. Rozen TD. Melatonin responsive hemicrania continua. Headache 2006;46:1203–1204.
99. Miano S, Parisi P, Pelliccia A, Luchetti A, Paolino MC, Villa MP. Melatonin to prevent migraine or tension-type headache in children. Neurol Sci 2008;29:285–287.
100. Nieminen P, Tolonen U, Lopponen H. Snoring and obstructive sleep apnea in children: A 6-month follow-up study. Arch Otolaryngol Head Neck Surg 2000;126:481–486.
101. Guilleminault C, Monteyrol PJ, Huynh NT, Pirelli P, Quo S, Li K. Adeno-tonsillectomy and rapid maxillary distraction in pre-pubertal children: A pilot study. Sleep Breath 2011;15:173–177.
102. Kuhle S, Urschitz MS, Eitner S, Poets CF. Interventions for obstructive sleep apnea in children: A systematic review. Sleep Med Rev 2009;13:123–131.
103. Report on the Findings of the Oral Health Component of the Canadian Health Measures Survey. 2007–2009. Ottawa: Publications Health Canada, 2010.