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CASE IN POINT

PEER REVIEWED

Growth, ADHD, and Sleep Apnea: A Case Review

Author:
Kristin A. Mock, MD
Family Medicine and Sleep Medicine, Sycamore, Illinois

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A 6-year-old girl presented for evaluation of difficulty concentrating in class and following directions since having recently started 1st grade.

The girl had been born after a normal pregnancy, except for well controlled gestational diabetes, by normal spontaneous vaginal delivery at 36 weeks of gestation. At birth, she was in the 22nd percentile for weight and the 1st percentile for height; at 1 year of age, she was in the 20th percentile for weight and the 39th percentile for height. She had progressively decreased in percentile for height and weight until, now at 6 years of age, she was below the 1st percentile for weight and the 2nd percentile for height.

Despite having an otherwise completely normal childhood, she had been referred to an endocrinologist at age 5 years and 11 months because of her poor growth. Results of an evaluation with a complete blood cell count, a comprehensive metabolic panel, thyroid tests, growth hormone tests, and iron studies were all within normal limits for her age. She was thought to have genetic short stature; although her parents were of average height, her maternal grandmother was of short stature at 5 feet tall. The endocrinologist gave no further recommendations for care, and the girl was referred back to primary care.

The girl then was referred to my practice for evaluation for attention-deficit disorder (ADD) or attention-deficit/hyperactivity disorder (ADHD). She had had some learning and behavioral problems in kindergarten and now in the 1st grade was having more classroom difficulties with

concentration and staying on task. Her parents had noted that she was different from their other children in that she took more time to complete tasks and was more forgetful. Her father had a history of ADHD but did not take medication because of its adverse effects.

During the evaluation for ADD/ADHD, the girl's history was suggestive of a sleep disturbance. The girl had been a long-time snorer (albeit not loudly) since toddlerhood, was restless when she slept, and had difficulties with arousing, taking longer than 30 minutes. The girl slept in extension rather than the typical curled-up position, and she rarely slept in the same position throughout the night. She was rarely well rested when she awoke and often fell asleep during class in the late afternoon.

She was sent for polysomnography and received a diagnosis of obstructive sleep apnea (OSA), defined in children as 2 missed breaths or the absence of inspiratory effort and flow for at least 20 seconds, a 3% desaturation, or bradycardia. Her apnea-hypopnea index (AHI) was 1.7; mild OSA is defined as an AHI from 1 to 4, moderate from 5 to 10, and severe greater than 10.[1] Her respiratory disturbance index (RDI)—AHI plus all other respiratory events that do not meet the criteria for apnea but cause arousal as measured with electroencephalography—was 4.9; an RDI greater than 1 indicates the presence of OSA.[1] In addition, her rapid eye movement (REM) AHI of 11.9 was suggestive of significantly worse disease during REM sleep, when atony is present.

The patient underwent tonsillectomy and adenoidectomy before following up with a secondary sleep study, the results of which showed persistent OSA, with an AHI of 3.0 but an RDI of 3.2 and REM AHI of 9.6. She had minimal improvement of clinical sleep dysfunction, still complaining of daytime sleepiness, difficulties with concentration at school, and restless sleep.

After beginning continuous positive-airway pressure (CPAP) therapy at titrated pressures of 8 cm H_2O, she experienced improvement in both her sleep efficiency and her ability to wake in the morning. She was able to tolerate class better with significantly fewer parental notifications; however, after several months, difficulties persisted with concentrating in class as evidenced by a continuation of parental notifications for behavior problems.

After evaluation by a social worker with Conners behavior testing and ADD/ADHD testing, she received a diagnosis of persistent ADHD. She was started on amphetamine/dextroamphetamine, which improved her concentration.

Of note, 6 months after starting CPAP therapy, at age 8 years, the girl's height and weight had improved to the 31st and 4th percentiles, respectively. The mother reported that after 6 months, she had had to buy several pairs of shoes and new clothes for the girl due to her rapid growth, advancing 3 sizes in clothing. The girl experienced progressive improvement in percentiles for

height and weight, and after 2 years of CPAP use, her weight and height had entered the 42nd and 18th percentiles, respectively.

DISCUSSION

The estimated prevalence of habitual snoring in children younger than 13 years of age varies greatly from 3% to 35%.[1] OSA has been estimated to affect approximately 2.0% to 3.5% of children, with 2 peak periods. The first peak occurs in children from 2 to 8 years of age with the presence of enlarged adenoids and/or tonsils. As children gain weight in adolescence, a second peaks arises.[1,2]

Sleep-disordered breathing (SDB) is a combination of OSA and upper airway resistance syndrome. SDB is more common among boys than girls after adolescence, with the prevalence increasing in association with weight gain.[3,4] SDB is more common among children with an elevated body mass index than their normal-weight counterparts. African American race has been found to be associated with an increased risk of SDB.[4] The presence of upper and lower respiratory disease and wheezing also is associated with an increased incidence of SDB.[4] In addition, persons with craniofacial or genetic abnormalities such as Pierre Robin syndrome, Apert syndrome, or Marfan syndrome, and persons with retrognathia are more likely to have SDB.[2]

Children with Down syndrome are more likely to have SDB, as well, due to associated macroglossia, thyroid dysfunction, and weight issues. SDB has been reported to be as common as 30% to 60% in this population,[5] and in one research, study sleep abnormalities were as high as 100%.[6] As a result, children with Down syndrome should receive a baseline sleep study at age 3 or 4, and sooner if symptoms of disordered sleep are present.[6]

The most common symptom of SDB is snoring, but it may present as frequent awakenings, restless sleep, frequent nightmares, secondary enuresis, difficulties with morning awakening, excessive daytime sleepiness, hyperactivity, behavior problems, inattention, poor sleep patterns, mouth breathing during daytime hours, and failure to thrive. Sleeping in a hyperextended position is abnormal in children and may reflect breathing disorders.[7] Children with OSA often have restless nocturnal sleep with frequent movement. Night terrors and sleepwalking also commonly accompany SDB in children.[7]

Growth suppression is a lesser-recognized adverse effect of OSA and is related to the fact that gonadotropin-releasing hormone, a growth-hormone precursor, is made at the onset of slow-wave sleep and is proportional to the amount of slow-wave sleep obtained.[8] Along with prolactin, growth hormone is immediately altered with a change in the sleep-wake cycle, while thyrotropin is influenced by both the sleep-deprivation profile and circadian rhythm. Sleep

typically inhibits the thyrotropin level from rising; thus, in the sleep-deprived patient, thyrotropin can increase further, causing alterations in thyroid function.[8]

Children who have fractured and interrupted sleep due to OSA have a greater propensity to show lower growth percentages. Researchers at the Children's Medical Center of Brooklyn demonstrated a positive correlation between change in height and weight attaining normal percentiles and adenotonsillectomy in children with OSA.[9] Although sleep has long been linked to proper growth, weight, and hormonal regulations, in my clinical experience, the quality of sleep is often disregarded by parents and clinicians alike.

OSA has been minimally studied as a causative factor of attention-deficit syndromes. The Childhood Adenotonsillectomy Trial (CHAT) showed improvements in behavior and quality of life in patients who were treated for their OSA with adenotonsillectomy rather than watchful waiting.[10] However, attention scales were unaltered.[10] In a small study of teenagers with obesity, school performance and attention scores improved with positive-airway pressure therapy, even those who were nonadherent.[11]

The standard for OSA diagnosis in children is in-laboratory polysomnography. The use of home sleep studies has not been validated in children. Children often display decreased effectiveness of breathing as a rising end-tidal carbon dioxide level as opposed to the classic decrease in respiratory amplitude. In addition, the criteria for sleep apnea in children (aged 1-18 years) are significantly different from those for adults, with an AHI of greater than 1 a significant finding.[1] The primary treatment strategy for children with OSA is evaluation for tonsillectomy and adenoidectomy, typically by an otorhinolaryngologist, with a caution in the published expert guidelines to keep children who are determined to be at higher risk in the hospital overnight following tonsillectomy.[12]

Children should have a repeated sleep study 6 to 12 weeks after surgical intervention to assure that OSA has resolved. If OSA persists, or if the patient is not a surgical candidate initially, CPAP is the secondary line of therapy for children. Although no definitive guideline yet exists, early sleep studies have been recommended due to the rapid rate of growth and change of the pediatric airways.

CONCLUSIONS

Pediatric sleep apnea is a grossly underrecognized sleep disorder[13] that often masquerades as attention deficits, behavioral dysfunction, and hyperactivity. According to pediatric guidelines, all children should be screened for snoring.[13] If snoring is present, further evaluation is necessary to determine whether symptoms of SDB exist, and then whether even further evaluation should occur, of which polysomnography is the gold standard.[13] The American Academy of Pediatrics

recommends that the evaluation for ADD/ADHD include assessment for underlying disorders that would explain disease, specifically sleep apnea.[14]

The National Sleep Foundation recommends daily sleep duration of 14 to 17 hours per day from birth to 3 months, 12 to 15 hours per day from 4 to 11 months, 11 to 14 hours per day for 1- to 2-year-olds, and 10 to 13 hours per day for preschoolers aged 3 to 5 years.[15] Children aged 6 to 13 years are recommended to have 9 to 11 hours of sleep nightly.[15] Although these recommendations are important, it is imperative that this be restorative sleep with normal breathing indexes. Left unrecognized in children, OSA can have profound negative effects on concentration, growth, obesity, behavior, school performance, and development of diabetes.

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