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Behavioral Changes in Children With Mild Sleep-Disordered Breathing or Obstructive Sleep Apnea After Adenotonsillectomy

Ron B. Mitchell, MD; James Kelly, PhD

Objective: To compare changes in behavior after adenotonsillectomy in children with either mild sleep-disordered breathing (SDB) or obstructive sleep apnea (OSA).

Study Design: Prospective cohort study.

Methods: Children at the University of New Mexico Children's Hospital, Albuquerque with mild SDB or OSA were included in the study. All children underwent preoperative polysomnography before adenotonsillectomy. Mild SDB was defined as an apnea-hypopnea index (AHI) less than 5 or an apnea index (AI) less than 1. OSA was defined as an AHI 5 or greater or an AI 1 or greater. Pre- and postoperative scores from the Behavioral Assessment System for Children (BASC) survey were compared using repeated measures analysis of variance.

Results: The mean preoperative AHI for children with mild SDB (n = 17) was 3.1 (range 1.7–4.7), and for children with OSA (n = 23) it was 25.3 (range 10.0–48.0). The mean preoperative BASC scores for children with mild SDB were not significantly different from the scores for children with OSA. The demographics in the two groups of children were similar. The behavior symptom index, a global measure of behavior, showed significant improvement after surgery for both groups of children ($P < .01$). Children also showed significant improvement after adenotonsillectomy in the BASC scales of atypicality, depression, hyperactivity, and somatization. Mean changes in BASC scores after adenotonsillectomy were not significantly different in the two groups of children.

Conclusions: Behavioral problems are prevalent in children with either mild SDB or OSA, and both groups of children show significant improvements in behavior after adenotonsillectomy.

Key Words: Sleep, child, tonsils, behavior.

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INTRODUCTION

Sleep-disordered breathing (SDB) in children represents a spectrum of disorders ranging in severity from primary snoring to more severe forms such as obstructive sleep apnea (OSA).[1] It is now known that SDB is associated with problems in child behavior that include hyperactivity, reduced attention, anxiety, depression, and somatic complaints.[2] Adenotonsillectomy, the primary surgical treatment for SDB in children, has been shown to lead to improvements in respiratory parameters and in behavior.[3,4]

The majority of children who undergo adenotonsillectomy for SDB have mild forms of the disorder.[5] It remains unclear, however, whether children with mild SDB have fewer behavioral problems than children with more severe forms of the disorder such as OSA. Equally, it is unknown whether surgical therapy leads to a greater improvement in behavior in children depending on the severity of preoperative SDB. This issue is of considerable clinical importance because adenotonsillectomy for mild forms of SDB in children may be unwarranted in some instances if surgery does not resolve the behavioral problems that are the principal complaint of caregivers.

All children included in the present study underwent full-night polysomnography to establish the presence of SDB and to document its relative severity.[1] Child behavior was evaluated before and after adenotonsillectomy using the Behavioral Assessment System for Children (BASC).[6] The goals of the study were to evaluate the relationship between the severity of SDB and child behavior and to compare changes in behavior after adenotonsillectomy in children who had comparable demographics but different severity of SDB.

From the Division of Pediatric Otolaryngology, Department of Otolaryngology–Head and Neck Surgery (R.B.M.), St. Louis University School of Medicine, St. Louis, Missouri, U.S.A.; and the Division of Otolaryngology, Department of Surgery (J.K.), University of New Mexico, Health Sciences Center, Albuquerque, New Mexico, U.S.A.

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Send correspondence to Dr. Ron B. Mitchell, Professor of Otolaryngology, Saint Louis University School of Medicine, Cardinal Glennon Children's Medical Center, 1465 S. Grand, Suite 4740, St. Louis, MO 63104. E-mail: rmitch11@slu.edu

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MATERIALS AND METHODS

Approval for this study was obtained from the Institutional Review Board of the University of New Mexico. The parents of children enrolled in the study signed an informed consent document. Children referred to the pediatric otolaryngology service with a sleep disturbance who were considered for adenotonsillectomy underwent polysomnography and were included in the study. Demographic information was collected for both caregiver and child. Exclusion criteria included 1) children less than 3 or more than 18 years of age; 2) children who previously had an adenotonsillectomy; and 3) children with craniofacial syndromes, neuromuscular disease, developmental delay, or those receiving regular medication for psychiatric disorders. The age- and sex-corrected body mass index was calculated for each child included in the study using established guidelines.[7]

All study participants underwent polysomnography to document the severity of SDB. The following parameters were used: four-channel electroencephalography with bilateral central and occipital leads; electro-oculography to measure vertical and horizontal eye movements; electromyography with submental electrodes; electrocardiography; airflow recording through the nose and mouth by a nasal air pressure transducer with end tidal CO_2; thoracic and abdominal effort by piezoelectric sensors; oxygen saturation through pulse oximetry; and tracheal sound recording using a microphone secured to the neck. Digital videotaping with sound recording was performed throughout the night. A sleep medicine physician interpreted the polysomnography results. The apnea-hypopnea index (AHI), defined as the average number of obstructive apneas and hypopneas per hour of sleep, was used for diagnosis of SDB. Obstructive apnea was defined as total absence of airflow through the mouth and nose with continued chest and abdominal movement for at least two respiratory cycles. Hypopneas were defined as a decrease in nasal flow of greater than 50% or with a corresponding decrease in oxygen saturation of 4% or less or with an arousal.[1] OSA was defined as an AHI 5 or greater or an apnea index (AI) 1 or greater. Mild SDB was defined as an AHI 1 or greater but less than 5 and an AI less than 1. Children with mild SDB were considered for surgical intervention, after informed consent was obtained, when the caregivers reported persistence or worsening of daytime and nighttime sleep symptoms. This was despite the presence of only a mild sleep disturbance on polysomnography. This is consistent with the practice of the majority of pediatric otolaryngologists.[8] The tonsillectomy was performed with a combination of sharp and blunt dissection using primarily a blade electrocautery. Adenoidectomy was performed using suction ablation and cautery.

Caregivers were asked to complete the BASC[6] survey prior to surgery and a second time within 6 months of surgery. Specific BASC instruments were used for the following age groups; 2.5 to 5 years; 6 to 11 years; and 12 to 18 years. The BASC behavioral scales are aggression, anxiety, attention problems, atypicality, depression, hyperactivity, somatization, and withdrawal. BASC composite scales are made up of several behavioral scales that are weighted differently as a function of age. This weighting reflects the relative contribution of individual scales to problem behaviors in different age groups. The composite scales are the behavioral symptoms index (BSI), externalizing problems, and internalizing problems. Only BASC scales and composites that were applicable to all age groups were included in this study. Responses to each question were scored as follows: never occurs = 0; sometimes occurs = 1; often occurs = 2; almost always occurs = 3. Raw scores on the BASC scales and composites were converted to T scores with a mean of 50 and an SD of 10. Children who scored from 60 to 69 were considered to have "borderline" behavioral impairment. Children who scored 70 or above were considered to have "clinically significant" behavioral impairment.

BASC T scores were compared before and after surgery using a paired t test. A P value less than or equal to .05 was considered significant. Children were also divided into three groups based on preoperative BASC scores: normal, T score less than 60; borderline, T score greater than or equal to 60 but less than 70; and clinically significant, T score greater than or equal to 70. This was done to determine the number of children who remained borderline or clinically significant after surgery. Preoperative and postoperative BASC scores for each group of children (OSA and mild SDB) were compared using a repeated measures analysis of variance. Changes between the two groups were compared using an analysis of covariance with the preoperative score as a covariate. SAS procedures (SAS Corp., Carey, NC) were used for statistical analyses.

A power analysis indicated that a sample size of 15 was adequate to detect a 10 point difference in BASC T scores with 80% power and $\alpha = 0.05$. Because a difference of 10 in a BASC T score is clinically significant, the present study has sufficient power to detect a significant change in behavior in both groups.

RESULTS

Forty-six children were included in the study. Two of these children were lost to follow-up, two others did not undergo adenotonsillectomy, and the caregivers for two children did not complete the postoperative BASC survey. As a consequence, the study population included 40 children, 17 with mild SDB and 23 with OSA. The demographics of children with mild SDB and those with OSA were similar and are presented in Table I. The mean AHI for children with mild SDB was 3.1 (range, 1.7–4.7), and for children with OSA it was 25.3 (range, 10–48). The follow-up period lasted 110 days in the group of children with mild SDB and 138 days in the group with OSA.

Mean BASC T scores before and after adenotonsillectomy, change scores, and confidence intervals (CI) for children with OSA and for children with mild SDB are presented in Table II. Scores for the BSI and for the individual behavioral scales atypicality, depression, hyperactivity, and somatization showed significant improvement after surgery for both groups of children ($P < .001$). The mean preoperative BASC scores for children with mild SDB were generally lower than for children with OSA, but these differences were not statistically significant. Similarly, the mean postoperative BASC scores for children with mild SDB were generally lower than for children with OSA, but these differences were not statistically significant.

TABLE I.
Characteristics of Study Population.

Characteristic	Mild SDB (n = 17)	OSA (n = 23)
Mean age in years (range)	7.3 (3.2–12.9)	6.9 (3.1–14.9)
Male	62%	48%
Mean BMI (range)	22 (12–44)	23 (12–46)
Obese (BMI >95th percentile)	19%	22%
Hispanic or Latino	38%	54%
Non-Hispanic or Latino White	35%	25%
Mean AHI (range)	3.1 (1.7–4.7)	25.3 (10–48)

SDB = sleep-disordered breathing; OSA = obstructive sleep apnea; BMI = body mass index; AHI = apnea-hypopnea index.

TABLE II.
Mean Behavior Assessment System for Children (BASC) T Scores for Children With Mild Sleep-Disordered Breathing (SDB) or Obstructive Sleep Apnea (OSA) Before and After Adenotonsillectomy.

BASC Scale	Preoperative Mean T Score	Postoperative Mean T Score	Mean Change (95% CI)	P Value
Children with mild SDB				
Atypicality	55.1	47.9	7.2 (1.9–12.5)	<.001
Depression	55.8	45.9	9.9 (4.2–15.6)	<.001
Hyperactivity	56.4	48.8	7.6 (2.9–12.3)	<.001
Somatization	60.4	48.7	11.8 (6.6–17.0)	<.001
BSI	57.3	47.3	10.0 (3.4–16.6)	<.001
Children with OSA				
Atypicality	55.4	48.0	7.4 (2.6–12.2)	<.001
Depression	56.3	49.1	7.2 (1.4–13.0)	<.001
Hyperactivity	57.0	47.9	9.1 (3.6–14.6)	<.001
Somatization	64.4	51.7	12.7 (8.7–16.7)	<.001
BSI	56.5	48.3	8.2 (3.0–13.4)	<.001

CI = confidence interval; BSI = Behavioral Symptoms Index.

The mean change in BSI was 10 (CI, 3.4–16.6) for children with mild SDB and 8.2 (CI, 3–13.4) for children with OSA. The BASC scale with the largest mean change score was somatization both for children with mild SDB and for children with OSA. The domain with the smallest mean change score was atypicality (mean change, 7.2; CI, 1.9–12.5) for children with mild SDB and depression (mean change, 7.2; CI, 1.4–13) for children with OSA. The differences in BSI and BASC scales for the two groups of children were not statistically significant.

The number of children with BSI scores that indicated borderline or clinically significant behavioral impairment ($T \geq 60$) before surgery was seven (41%) for those with mild SDB and six (26%) with OSA. After adenotonsillectomy, two (12%) children with mild SDB and three (13%) children with OSA had BSI scores that indicated borderline or clinically significant behavioral impairment.

DISCUSSION

The results of this prospective study suggest that behavioral problems associated with SDB are not related in a simple way to the severity of a child's sleep disorder. All 40 children included in the present study underwent polysomnography to document the severity of their sleep disturbance. Behavioral problems associated with SDB were evaluated by caregiver proxy using the BASC survey instrument. These behavioral problems include atypicality, depression, hyperactivity, and somatization and occur regardless of the relative severity of SDB. Significant improvement occurs in behavioral scales after adenotonsillectomy, but the degree of improvement is independent of the severity of preoperative SDB.

Previous studies using the BASC behavioral instrument[4,5] have shown that children with OSA have a significant improvement in behavioral scales after adenotonsillectomy. The BSI, a total behavioral score, showed mild to severe behavioral impairment in 37% of the children.[4] In the majority of children with behavioral problems, T scores placed them in the "borderline" rather than the "clinically significant" category, but nearly all children improved after adenotonsillectomy. This study confirms these findings but also shows that children with mild SDB may have similar behavioral problems that also improve significantly after surgical therapy.

Several previous studies have examined the association between child behavior and the severity of SDB.[2] Kaemingk et al.[9] found that children with an AHI greater than 5 had significantly more problems with learning and memory than children with an AHI less than 5. In contrast, Owens et al.[10] and Friedman et al.[11] showed little correlation between behavioral problems and the severity of OSA as measured by polysomnography. Unfortunately, these findings were limited by small study populations that may not have provided sufficient statistical power. However, a recent study by Chervin et al.[12] that included 105 children with polysomnography-proven SDB failed to show a significant association between the severity of baseline SDB and behavioral problems. Furthermore, several studies have shown that even children with primary snoring[13,14] have more social problems, more symptoms of anxiety and depression, as well as decreased attention and memory when compared with nonsnoring children.

There are a number of explanations for the remarkable finding that both mild SDB and OSA in children are associated with similar behavioral problems. First, the severity of SDB was measured by the AHI in this study. It is possible that other parameters of sleep behavior measured objectively with polysomnography may correlate more closely with behavioral problems. In children with primary snoring, Kennedy et al.[14] showed that increased numbers of oxygen desaturations and respiratory arousals are associated with greater impairment of neurocognitive performance, particularly intelligence and memory. Clearly, in future research, it would be helpful to examine a variety of respiratory and nonrespiratory parameters measured by polysomnography and correlate them with behavioral scales affected by SDB. Finally, in this study, child behavior was evaluated using caregiver proxy reports from the BASC survey instrument. Direct neuropsychological testing of children may have revealed aspects of behavior that correlate more closely with the severity SDB as measured by polysomnography.

The strengths of the present study are its prospective design and the fact that all children underwent objective evaluation with polysomnography to establish the relative severity of their sleep disorder. However, the study also has a number of limitations. It was not feasible to withhold surgical treatment for a period of several months in children with SDB, and consequently there was no control group. A comparison group of children undergoing adenotonsillectomy for recurrent throat infections but without SDB may have been useful in excluding the placebo effect of surgical intervention. Based on the present study, it cannot be stated with certainty that a causal relationship exists between adenotonsillectomy and improvements in behavior. To some degree, these improvements, seen in a relatively small number of 40 children, may represent regression toward the mean or the natural tendency of the behavioral problems to resolve over time. Second, children in this study were recruited from an otolaryngology clinic where they were seen for a sleep disturbance and considered for surgical therapy. This introduced a selection bias because these children were more likely to be symptomatic than were children with a similar condition whose caregivers did not seek surgical intervention. Third, the follow-up period was less than 6 months and did not include postoperative polysomnography. It is conceivable that children with mild SDB respond differently to surgical therapy as compared with children with OSA when followed for a longer time. Equally, it is difficult to correlate the sleep apnea or SDB improvement with the improvement in BASC scores. Many of these limitations are a reflection of the difficulties in studying the outcome of surgery on behavior in a large number of children with SDB with suitable controls and objective outcome measures, as discussed in an excellent review by Ebert and Drake.[15] Nonetheless, improvements in child behavior in the short term after adenotonsillectomy appear to be significant regardless of the severity of the sleep disorder.

CONCLUSION

The results of this study suggest that SDB may be associated with significant behavioral problems regardless of the relative severity of the sleep disorder. These behavioral problems improve after adenotonsillectomy, but the extent of improvement is not related to whether a child has mild SDB or OSA.

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