The Effect of Body Position on Sleep Apnea in Children Younger Than 3 Years

Kevin D. Pereira, MD; Jeremy C. Roebuck, MD; Lori Howell, BS

Objective: To determine the association between body position and obstructive events during sleep as determined by polysomnography (PSG) in very young children (age, ≤3 years) with obstructive sleep apnea syndrome.

Design: Retrospective chart review.

Subjects: Children aged 3 years and younger who underwent PSG to evaluate obstructive sleep apnea and subsequently underwent adenotonsillectomy between December 1, 2000, and November 30, 2003, were included in the study. The PSGs were analyzed for data on the respiratory disturbance index (RDI), time spent in each body position, number of apneic events in each position, oxygen saturation, and time spent in each stage of sleep. The results determined the statistical significance of these parameters.

Results: Sixty patients satisfied the criteria for inclusion in the study. The mean supine sleep RDI was 8.5 compared with 4.9 for the mean nonsupine sleep RDI. The mean RDI increased from 5.6 to 8.5 when more than 50% of the time was spent in supine sleep. There was a further increase to 10.5 when supine sleep increased to 75% of the total sleep time. The mean RDI in rapid eye movement sleep was 20.5 compared with 5.3 in non-rapid eye movement sleep. The mean ± SD supine sleep RDI was 18.5 ± 5.1, and the mean nonsupine RDI was 7.2 ± 1.9, which was statistically significant (P = .02).

Conclusions: There is an increase in the RDI with increased time spent in supine sleep in very young children with obstructive sleep apnea. Inadequate time spent in that position may lead to an underestimation of the severity of obstructive sleep apnea. A combination of reduced rapid eye movement sleep and increased nonsupine sleep may invalidate the findings of PSG in these children.


Pediatric obstructive sleep apnea syndrome (OSAS) is characterized by partial or complete upper airway obstruction that occurs during sleep. It has been extensively researched in adults. The pathophysiologic features and most of the contributing factors of OSAS are well known. The syndrome affects between 2% and 4% of middle-aged adults, with supine sleep contributing to the symptoms. A study by Cartwright et al1 shows that in adult patients there is a significant decrease in OSAS episodes when the supine position is avoided. However, the entity is not as well understood in children. Some studies have reported that sleep position does not affect the severity of OSAS in children.2 It has also been suggested that children breathe better when they sleep in the supine position. Decreased time in a position in which most obstructive events occur could result in underreporting of the disorder in children. Although most studies were performed in the pediatric age group, to our knowledge none of them looked at very young children. The purpose of the present study was to evaluate the effect of body position on OSAS as diagnosed by polysomnography (PSG) in children younger than 3 years.

Methods

The study was approved by the institutional review board and the Committee for the Protection of Human Subjects of The University of Texas Health Science Center at Houston. Sixty sleep studies performed at the Memorial Hermann Hospital Sleep Disorders Center, Houston, were reviewed. The study population included patients 3 years of age and younger evaluated with PSG between December 2001 and December 2003. Clinical characteristics of the patients were documented from their clinic charts. The clinical impression of the primary otolaryngologist was recorded, including a grading of adenotonsillar hypertrophy. Data recorded from the sleep studies included age, sex, total sleep time, time spent in supine sleep, time spent in rapid eye movement (REM) sleep, REM respiratory disturbance index (RDI), supine RDI, nonsupine RDI, total RDI, lowest oxygen saturation, apnea index, and clinical impression.
Obstructive sleep apnea syndrome is a serious medical problem, affecting 500,000 children per year in the United States. Pediatric OSAS peaks between the ages of 2 and 5 years, with an overall prevalence of 2%. The hallmarks of OSAS include episodes of partial or complete upper airway obstruction that occur during sleep, manifested by snoring, retractions, paradoxical chest motion, cyanosis, and poor quality of sleep. The condition is usually accompanied by a nocturnal reduction in oxygen saturation and hypercarbia. Symptoms during the day include mouth breathing, behavior problems, hyperactivity, and excessive daytime sleepiness (less than in adults). Nocturnal enuresis and asphyctic encephalopathy have also been reported. When these manifestations result from adenotonsillar hypertrophy, most of them have been shown to be reversed by adenotonsillectomy. In 1998, Wang et al reported that enuresis is the clinical entity that most accurately predicts OSAS on PSGs. Other signs and symptoms of the disorder may be less reliable predictors of OSAS as diagnosed by PSG. Symptoms such as snoring and daytime somnolence may actually represent other conditions, eg, primary snoring or upper airway resistance syndrome.

The results of our study indicate that supine sleep does correlate with an increase in RDI as well as with OSAS in pediatric patients younger than 3 years. This finding is in contrast to previous studies that have demonstrated no correlation between sleep position and OSAS in children. In 2001, Penzel et al demonstrated the collapsibility of the upper airways in adults who were in the supine position and showed that this outcome depended on sleep position and not on sleep stage. However, adult sleep apnea differs from pediatric apnea in several aspects, and the exact mechanism of pediatric OSAS has not been fully elucidated. A recent study suggested that children younger than 10 years actually breathe better in the supine position than in the lateral or the prone position. In that study, the patients had a lower RDI in the supine position compared with other positions. Our study in very young children showed evidence to the contrary. Our observations suggest that toddlers have sleep characteristics that are different from those of older children. Sleep studies may have to take these age group differences into consideration before declaring the findings adequate for interpretation. Very few infants were included in our study, and we did not specifically look at the breathing parameters in this age group. Therefore, we cannot comment on the relevance of our findings to the practice of putting infants to sleep on their backs to avoid sudden infant death syndrome.

**RESULTS**

In the 60 sleep studies reviewed, the mean±SD RDI score was 10.8±3.4 (Figure 1). The mean±SD total sleep time was 6.5±1.9 hours, with an average of 40% in the supine position. There was a statistically significant difference (paired t<sub>50</sub>=2.6; P=.01) in the RDI (13.5) of children in the supine position when compared with the RDI (10.8) of children when all positions were included. Also, analysis revealed that as supine sleep decreases when compared with percentage of total sleep time, the RDI decreases. The percentages of supine sleep for varying values were compared using t test analysis. For patients with supine sleep greater than 50% of total sleep time, there was an increase in the RDI, although the increase was not statistically significant (P>.05). Rapid eye movement sleep also correlated with an increased RDI (20.5) compared with non-REM results (13.6) (Figure 2). The most significant finding in the study was that the RDI in the supine position was greater than in all other positions combined (prone, left lateral decubitus, and right lateral decubitus). The mean±SD supine RDI was 18.5±5.1, and the mean±SD nonsupine RDI was 7.2±1.9, which was statistically significant (P=.02).

**COMMENT**

![Figure 1](https://via.placeholder.com/150)

**Figure 1.** There was a strong correlation between the mean±SD total respiratory disturbance index (RDI) and the mean±SD supine RDI. The supine RDI (13.5±3.0) was significantly greater than the total RDI (10.8±3.4) (paired t<sub>50</sub>=2.6; P=.01).

![Figure 2](https://via.placeholder.com/150)

**Figure 2.** There was a strong correlation between the total respiratory disturbance index (RDI) and the rapid eye movement (REM) sleep RDI. The total RDI was positively related to the REM RDI (r=0.83, P=.001).
Pediatric OSAS is most commonly caused by enlarged tonsils and adenoids, with increased symptoms during REM sleep, and the patients usually have an excellent response to adenotonsillectomy. It is thus imperative that clinicians who use PSG take into consideration the variables that may affect the validity of the results. Our study findings suggest that an inadequate amount of time in REM sleep and the supine position may result in the underdiagnosis of sleep-disordered breathing in very young children. Lack of adequate supine sleep may be an important factor in symptomatic children with normal sleep study results. It also raises significant questions about using PSGs as the “gold standard” for the diagnosis and management of sleep-disordered breathing in children. A larger number of patients may be required to validate our observations.

Submitted for Publication: February 3, 2005; final revision received May 4, 2005; accepted May 27, 2005.

Correspondence: Kevin D. Pereira, MD, Department of Otolaryngology—Head and Neck Surgery, University of Texas Professional Bldg, 5410 Fannin, Suite 1200, Houston, TX 77030 (kpereira@uth.tmc.edu).

Author Contributions: Dr Pereira had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Financial Disclosure: None.

Previous Presentation: This study was given a President’s Award for the Best Scientific Poster presented at the American Academy of Otolaryngology—Head and Neck Surgery Annual Meeting; September 19, 2004; New York, NY.

References