Prevalence and Risk Factors of Positional Obstructive Sleep Apnea (POSA) among Children with Obstructive Sleep Apnea

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Abstract

Objective: This study aimed to assess the prevalence and risk factors of positional obstructive sleep apnea (POSA) among children with OSA.

Methods: A retrospective study was conducted. One hundred and three children with OSA who were aged 3 to 18 years between April 2013 and July 2021 were included in this study. Demographic and polysomnographic data were gathered.

Results: The prevalence of POSA was 42.7%. No significant differences were observed in age, gender, tonsil score, weight status and medical comorbidities. Children with POSA had a significantly higher supine AHI than non-POSA (9.6 [0.0-98.7] versus 4.7 [0.0-55.4], p = 0.012). The median non-supine AHI of POSA was significantly lower than non-POSA (0.0 [0.0-18.6] versus 5.3 [0.0-78.9], respectively p < 0.001).

Conclusion: POSA among children with OSA occurs frequently, similar to adults with POSA. POSA is associated with higher supine AHI and lower non-supine AHI. Positional therapy might be beneficial in children with POSA.

Keywords: positional obstructive sleep apnea, obstructive sleep apnea, children

ความชุกและปัจจัยเสี่ยงของเด็กที่มีภาวะหยุดหายใจขณะหลับจากการอุดกั้นที่ขึ้นกับท่านอน

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บทคัดย่อ

วัตถุประสงค์: เพื่อศึกษาความชุกและปัจจัยที่เกี่ยวข้องกับภาวะหยุดหายใจขณะหลับจากการอุดกั้นที่ขึ้นกับท่านอนในผู้ป่วยเด็กที่มีภาวะหยุดหายใจขณะหลับจากการอุดกั้น

วิธีดำเนินการวิจัย: งานวิจัยนี้เป็นการศึกษาแบบย้อนหลังโดยศึกษาในผู้ป่วยเด็กภาวะหยุดหายใจขณะหลับจากการอุดกั้น 103 คน อายุ 3 ปี ถึง 18 ปี ที่คณะแพทยศาสตร์วชิรพยาบาลระหว่างเดือนเมษายน พ.ศ. 2556 ถึงเดือนกรกฎาคม พ.ศ. 2564 โดยเก็บข้อมูลจากเวชระเบียนและผลการตรวจติดตามการนอนหลับ

ผลการวิจัย: ภาวะหยุดหายใจขณะหลับจากการอุดกั้นที่ขึ้นกับท่านอนคิดเป็นร้อยละ 42.7 ไม่พบความสัมพันธ์ของอายุ เพศ ขนาดต่อมทอนซิล น้ำหนักตัว โรคประจำตัวกับภาวะหยุดหายใจขณะหลับจากการอุดกั้นที่ขึ้นกับท่านอน โดยพบค่าเฉลี่ยของจำนวนที่หยุดหายใจและหายใจแผ่วแสดงในท่านอนหงาย (supine AHI) สูงในผู้ป่วยเด็กภาวะหยุดหายใจขณะหลับจากการอุดกั้นที่ขึ้นกับท่านอน (POSA) เมื่อเปรียบเทียบกับเด็กที่ไม่มีภาวะหยุดหายใจขณะหลับจากการอุดกั้นที่ขึ้นกับท่านอน (non-POSA) (9.6 [0.0-98.7] และ 4.7 [0.0-55.4], p = 0.012) และค่าเฉลี่ยของจำนวนที่หยุดหายใจและหายใจแผ่วแสดงในท่านอนอื่น ๆ (non-supine AHI) ในผู้ป่วยเด็กภาวะหยุดหายใจขณะหลับจากการอุดกั้นที่ขึ้นกับท่านอน มีค่าต่ำกว่าเมื่อเปรียบเทียบกับเด็กที่ไม่มีภาวะหยุดหายใจขณะหลับจากการอุดกั้นที่ขึ้นกับท่านอน (0.0 [0.0-18.6] และ 5.3 [0.0-78.9], p < 0.001)

สรุป: ภาวะหยุดหายใจขณะหลับจากการอุดกั้นที่ขึ้นกับท่านอนในเด็กพบได้บ่อย ซึ่งอุบัติการณ์ใกล้เคียงกับภาวะหยุดหายใจขณะหลับจากการอุดกั้นที่ขึ้นกับท่านอนในผู้ใหญ่ ซึ่งสัมพันธ์กับค่าเฉลี่ยของจำนวนที่หยุดหายใจและหายใจแผ่วแสดงในท่านอนหงายที่มีระดับสูง และค่าเฉลี่ยของจำนวนที่หยุดหายใจและหายใจแผ่วแสดงในท่านอนอื่น ๆ ในระดับต่ำ การรักษาโดยปรับท่านอนน่าจะเป็นประโยชน์ในภาวะหยุดหายใจขณะหลับจากการอุดกั้นที่ขึ้นกับท่านอนในเด็ก

คำสำคัญ: ภาวะหยุดหายใจขณะหลับจากการอุดกั้นที่ขึ้นกับท่านอน ภาวะหยุดหายใจขณะหลับจากการอุดกั้นในเด็ก

Introduction

Obstructive sleep apnea (OSA) is characterized by recurrent upper airway obstruction associated with intermittent nocturnal hypoxia and sleep disruption. OSA occurs in 1- 4% of healthy children, while the prevalence of OSA among children with comorbidities such as obesity, craniofacial malformation, and Down syndrome is 60-80%[1-3]. There is evidence that body position during sleep can affect the severity of OSA. This is known as positional obstructive sleep apnea (POSA), present predominantly in the supine sleeping position[4]. POSA is defined by a supine apnea-hypopnea index (AHI) at least twice in a non-supine position[5]. Studies for POSA in children are limited. It has been established that 19% of children with OSA and 58% of obese children with OSA have POSA, while 55% of adults with OSA have POSA[6-8]. Several factors may affect the sleep position on OSA severity, including age, obesity, and history of adenotonsillectomy (A&T)[9-10]. A&T is the first line of management for children with OSA, but the success rate is only 51% for both obese and non-obese children[11]. Continuous positive pressure therapy (CPAP) is the main therapy for persistent OSA in children following A&T. However, adherence rates to CPAP are low[12]. There are alternative treatments for POSA in children, such as positional therapy[13]. This study aimed to evaluate the prevalence of POSA and identify the factors associated with POSA in children.

Methods

Study design and participants

This was a retrospective study performed with 151 children at the Vajira Sleep Center, Navamindradhiraj University from April 01, 2013 to July 31, 2021. One hundred and three patients aged between 3-18 years undergoing a baseline diagnostic polysomnogram (PSG) with a diagnosis of OSA were included in the study. The criteria used for diagnosis of OSA is the obstructive apnea-hypopnea index (AHI) > 1/h; further delineating the severity as mild OSA (AHI > 1-5/h), moderate OSA (AHI > 5-10/h), and severe OSA (AHI > 10/h).

The exclusion criteria included patients with only a supine position, a PSG-measured total sleep time (TST) of less than 6 hours, and subjects with bradycardia or tachycardia.

Data acquisition

Data collection from the medical records and PSG results included age, gender, weight, height, tonsil size, underlying disease, total sleep time (TST), total AHI, supine AHI, non-supine AHI, mean oxyhemoglobin saturation (SpO_2), and minimal SpO_2.

Weight status determinations (normal weight, overweight, and obesity) were made using the median weight-for-height on growth charts from the Department of Health, Ministry of Public Health, Thailand[14]. According to definitions from the Ministry of Public Health, obesity is defined as a median of weight-for-height > median +3 SD, overweight as a median of weight-for-height ≤ median +3 SD and > median +2 SD, and normal weight as a median of weight-for-height ≤ +2 SD and ≥ -2 SD. Tonsils were graded from 0-4 by Brodsky[15]. Subjects were divided into three age groups: < 6 years, 6-12 years, and > 12 years. Medical comorbidities were categorized as respiratory diseases including allergic rhinitis and asthma, cardiovascular diseases including hypertension and valvular heart disease, and neurological disorders including epilepsy, Down syndrome and attention deficit hyperactivity disorder.

POSA is defined by a supine AHI at least twice that in a non-supine position. PSG includes electroencephalography (EEG), electro-oculography, submental and anterior tibialis electromyography, electrocardiography, oronasal airflow, thoracoabdominal movement, positions, snoring, and oxygen saturation. PSG was attended by a trained sleep technician. Sleep staging and respiratory scoring were interpreted by sleep physicians using the criteria defined by the American Academy of Sleep Medicine[16]. The AHI was defined as the combined number of apneas and hypopneas recorded per hour of sleep. Apnea was defined as when the peak

signal excursions decreased by more than 90% of the pre-event baseline for at least two breaths. Hypopneas were defined as the peak signal excursions being decreased by more than 30% of the pre-event baseline for at least two breaths and were associated with more than 3% oxygen desaturation or EEG arousal[16].

Statistical analysis

Descriptive statistics were described as frequencies and percentages for categorical variables. Continuous variables were presented as means ± standard deviation or median (range) when the variables were not distributed normally. A Chi-square test was performed for analyzing the categorical variables. The differences in continuous variables between POSA and non-POSA were compared using the independent sample t-test and Mann-Whitney test with a significance level set at $p < 0.05$. All statistical analyses were performed using SPSS version 28.0 (IBM Corporation, Armonk, NY).

Results

One hundred and three children were enrolled in this study, including 78 males (75.7%), and the mean age was 8.45 ± 3.93 years old. Most of the children were from 6 to 12 years old (55.3%). In these children, tonsil grade 3 was 42.7% (49) and grade 4 28.2% (29). Children who were obese and overweight accounted for 43.7% (n=45) and 9.7% (n=10), respectively. Among these, 44 (42.7%) fulfilled the criteria for POSA, and 59 (57.3%) were non-POSA. Demographic data are given in Table 1.

We classified 103 children based on OSA severity; 38 (36.9%) were categorized as mild OSA, 29 (28.2%) were moderate OSA, and 36 (35%) were severe OSA. Overall, the median total AHI was 6.6 (1.3-98.7) events/hr. PSG data are summarized in Table 2.

Table 1 Demographic data (n=103)

Characteristics	Mean ± SD
Age in years	8.45 ± 3.93
Weight in kg	46.52 ± 30.09
Height in cm	133.47 ± 23.24
Tonsil score size, n (%)	
0	2 (1.9)
1	10 (9.7)
2	18 (17.5)
3	44 (42.7)
4	29 (28.2)
Gender, n (%)	
Male	78 (75.7)
Female	25 (24.3)
Medical comorbidities, n (%)	
Respiratory disease	12 (11.7)
Cardiovascular disease	12 (11.7)
Neuro-psychiatric disease	6 (5.8)

Table 2 Polysomnographic data (n=103)

Sleep study parameters	Mean ± SD
TST (min)	443.88 ± 72.66
Total AHI (events/hr.), median (range)	6.6 (1.3-98.7)
Supine AHI (events/hr.), median (range)	7.0 (0.0-98.7)
Non-supine AHI (events/hr.), median (range)	3.9 (0.0-78.9)
Mean SpO_2 (%)	95.36 ± 8.92
Minimal SpO_2 (%)	83.20 ± 9.23

The mean age of POSA and non-POSA was 8.52 ± 0.62 and 8.38 ± 0.49 years, respectively. Thirty-five males and nine females were POSA. The median total AHI for POSA and non-POSA were 8.7 (2.0-98.7) and 5.3 (1.3-54.9) events/hr., respectively. There were no significant differences between the POSA group and the non-POSA group in terms of age, weight, height, tonsil score, gender, medical comorbidities, TST, total AHI, mean SpO_2, and minimal SpO_2. The non-supine AHI was significantly lower in children with POSA (0.0 [0.0-18.6] versus 5.3 [0.0-78.9], $p < 0.001$). There was a trend for the POSA group to have a higher supine AHI compared with the non-POSA group (9.6 [0.0-98.7] versus 4.7 [0.0-55.4], $p = 0.012$). Comparison characteristics and PSG data between POSA and non-POSA are shown in Table 3.

There was found to be an increase in POSA with older age (52.94%), being overweight or obese (44.82%), and moderate to severe OSA (47.69%). No significant difference was found for the age group, weight status and OSA severity between children with POSA and without POSA. Data for age group, weight status, and OSA severity are shown in Table 4.

Table 3	Baseline characteristics and polysomnographic comparison between POSA and non-POSA

	POSA (n=44)	Non-POSA (n=59)	*p* value
Age (year)	8.52 ± 0.62	8.38 ± 0.49	0.866
Weight (kg)	47.67 ± 32.42	45.66 ± 28.47	0.739
Height (cm)	135.31 ± 23.42	132.10 ± 23.20	0.490
Tonsil score, n (%)			0.452
0	1 (2.3)	1 (1.7)	
1	6 (13.6)	4 (6.8)	
2	7 (15.9)	11 (18.6)	
3	15 (34.1)	29 (49.2)	
4	15 (34.1)	14 (23.7)	
Gender, n (%)			0.435
Male	35 (79.5)	43 (72.9)	
Female	9 (20.5)	16 (27.1)	
Underlying disease, n (%)			0.923
Respiratory disease	5 (38.4)	7 (41.2)	
Cardiovascular disease	6 (46.2)	6 (35.3)	
Neuro-psychiatric disease	2 (15.4)	4 (23.5)	
TST (min)	429.15 ± 91.83	452.88 ± 57.06	0.140
Total AHI (events/hr.), median (range)	8.7 (2.0-98.7)	5.3 (1.3-54.9)	0.191
Supine AHI (events/hr.), median (range)	9.6 (0.0-98.7)	4.7 (0.0-55.4)	0.012
Non-supine AHI (events/hr.), median (range)	0.0 (0.0-18.6)	5.3 (0.0-78.9)	<0.001
Mean SpO_2 (%)	94.50 ± 13.50	96.01 ± 1.93	0.396
Minimal SpO_2 (%)	83.18 ± 7. 88	83.21 ± 10.19	0.986

Table 4	Comparison of POSA and Non-POSA in different age group, weight status and OSA severity		
Data	POSA (n=44)	Non-POSA (n=59)	*p* value
Age, n (%)			0.645
< 6 years	12 (27.3)	17 (28.8)	
> 6-12 years	23 (52.3)	34 (57.6)	
> 12 years	9 (20.4)	8 (13.6)	
Weight status defined by weight-for-height, n (%)			0.830
Obesity	21 (47.7)	27 (45.8)	
Overweight	5 (11.4)	5 (8.4)	
Normal weight	18 (40.9)	27 (45.8)	
OSA severity, n (%)			0.409
Mild	13 (29.6)	25 (42.4)	
Moderate	14 (31.8)	15 (25.4)	
Severe	17 (38.6)	19 (32.2)	

Discussion

In our study, the prevalence of POSA was 42% among children with OSA (when defined as obstructive events occurring twice as often in the supine than non-supine sleep position). Nisbet et al. also showed that children aged 0-18 years who were positional patients when using at least twice the AHI in one sleep position than other position and high supine AHI were 31% and 54%, respectively[17]. The prevalence of POSA was estimated at approximately 55% among adults with OSA[8,18].

The definition of POSA establishes various criteria. Cartwright et al. described that POSA is defined as a difference of ≥ 50% in obstructive AHI between supine and non-supine positions[5]. Marklund et al. defined supine-dependent sleep apnea as a supine AHI more than 10 with lateral AHI less than 10[19]. Mador et al. suggested that POSA is defined as AHI < 5 /h in a non-supine position and a decrease of AHI more than 50% between supine and non-supine position[20]. Bignold et al. showed that position-dependent is defined as a total AHI ≥ 15/h, supine AHI as at least twice non-supine AHI and non-supine AHI < 15/h with ≥ 20 min of sleep in supine and non-supine sleep positions[21]. The new criteria, the Amsterdam Positional OSA Classification (APOC) introduced positional therapy and defined it as 1) AHI > 5/h, 2) > 10% of TST in both the best sleep position (BSP) and the worst sleep position, 3) BSP less than five, 4) lower OSA severity in BSP than total AHI or total AHI ≥ 40/h and a decreased AHI in BSP ≥ 25% compared to total AHI. No universal criteria exist for POSA in children[8]. A study by Verhelst et al. found that the prevalence of children with POSA and those with Down syndrome were 19% and 22.2%, respectively[6]. Previous studies reported that POSA among children with OSA and obesity were 30.3-58%[6-7]. Our data found 43.75% of POSA among children with obesity, which was not different from non-POSA children.

Previous studies examined the relationship between POSA and risk factors including age, obesity, tonsil size, and AHI. Zhang et al. reported that the left lateral decubitus AHI was significantly lower than supine AHI in children aged 6 to 13 years ($p < 0.05$)[22]. Cuhadaroglu et al. demonstrated that children with adenotonsillar hypertrophy had the highest AHI in the supine position ($p < 0.001$)[9].

A previous study by Verhelst et al. reported the association between POSA and age, obesity, tonsil size, AHI, supine AHI, and non-supine AHI[6]. In the study of Selvadurai et al., both significantly higher supine AHI and lower non-supine AHI were found in the POSA group, while the non-POSA group had a significantly lower mean SpO_2%[7]. Also, there was no association between POSA and non-POSA with a history of previous A&T[7]. In a recent study, children with POSA had a significantly higher supine AHI and a lower non-supine AHI; there were no significant differences in age, gender, or obesity in syndromic children[23]. Similar to our findings, no significant differences in age, gender, obesity, tonsil size and medical comorbidities were uncovered. Our study found that supine AHI and non-supine AHI were related to risk factors among children with POSA. Children with OSA worsened during REM sleep. However, time spent in a supine versus non-supine sleep position and REM versus non-REM sleep may be affected by both supine AHI and non-supine AHI. Verhelst et al. also reported that the supine AHI was higher than the non-supine position during REM sleep[6]. By contrast, Selvadurai et al. showed that supine AHI and non-AHI were no significantly different between children with POSA and those without POSA during REM sleep[7]. Previous research found that the severity of OSA had a significant difference in adults with POSA[24-25]. In contrast to our study, the severity of OSA was not significantly different in children with POSA.

Children with POSA are considered to benefit from positional therapy, which is an alternative treatment option. However, there is little data on the efficiency of positional therapy among children with OSA.

This study has several limitations. This is a retrospective study that used a small sample size and a single center. The majority of subjects were children who were overweight or obese and had a higher risk for OSA. The diagnosis of POSA is based on PSG that is considered for night-to-night variability in severity OSA and sleep position.

Conclusion

The prevalence of POSA among children with OSA was found to be 42%. Higher supine AHI and lower non-supine AHI were factors associated with POSA. Future studies should investigate the diagnosis criteria and anatomy collapsing in children with POSA for treatment beyond A&T.

Conflict of interest

The authors have no conflict of interest to declare.

Acknowledgment

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