Sleep-disordered breathing in 15-year-old boy with arterial hypertension

Madaeva Irina Michailovna, Kolesnikova Lubov Ilyinichna, Dolgikh Vladimir Valentinovich, Berdina Olga Nikolaevna

Scientific Centre of Family Health and Human Reproduction Problems of Siberian Branch of Russian Academy of Medical Sciences, Timiryazev St., 16, 664003 Irkutsk, Russia

A R T I C L E   I N F O

Article history:
Received 29 October 2012
Received in revised form
10 November 2012
Accepted 14 November 2012

Keywords:
Sleep-disordered breathing
Adolescents
Nasal continuous positive pressure in the upper airway
Arterial hypertension

A B S T R A C T

Obstructive sleep apnea/hypopnea syndrome (OSA/HS) is the basis of the spectrum of sleep-disordered breathing (SDB) and is a condition characterized by the presence of snoring, repetitive partial upper airway obstruction (hypopnea) and/or intermittent complete obstruction (apnea), long enough to cause reduce the level of oxygen in the blood (desaturation), fragmented sleep and excessive daytime sleepiness. It is known that OSA/HS in the middle and older age predisposes to arterial hypertension (AH). We discuss a case of 15-year-old boy with AH and OSA/HS. He was treated on nasal continuous positive pressure in the upper airway (nasal CPAP) with good results.

© 2012 Elsevier Ltd. Open access under CC BY-NC-ND license.

1. Introduction

In recent years, increased attention has received obstructive sleep apnea/hypopnea syndrome (OSA/HS). This syndrome is the basis of the spectrum of sleep-disordered breathing (SDB) and is a condition characterized by the presence of snoring, repetitive partial upper airway obstruction (hypopnea) and/or intermittent complete obstruction (apnea), long enough to cause reduce the level of oxygen in the blood (desaturation), fragmented sleep and excessive daytime sleepiness. The diagnosis of OSA/HS should be made if the episodes of apnea lasting at least 10 s and there are at least 5 times per hour.1

In the general population OSA/HS occur in 9% of women and 24% of men,2 in children and adolescents – 3%.3 It is known that 70–90% of middle-aged and older patients with OSA/HS meet arterial hypertension (AH).4 However, adequate data are not currently available to support this relationship in children and adolescents.

Major advances in the treatment of patients with OSA/HS is the development of equipment for a nasal continuous positive airway pressure therapy during the night (nasal CPAP).5 Little is known about nasal CPAP adherence among children and adolescents.

We present a case of adolescent, where both OSA/HS and AH were diagnosed simultaneously. He underwent a nasal CPAP therapy consists of 30 sessions during 3 months.

2. Methods

15-year-old boy admitted to the Clinic of Scientific centre of family health problems and human reproduction of Siberian branch of Russian Academy with complaints about the snoring, “unrefreshing” sleep, excessive daytime sleepiness, frequent morning headaches, poor concentration and memory, rises of blood pressure level to 140/90 mmHg.

On physical examination, was found adenotonsillar hypertrophy and his mandible was recognized as being hypoplastic. Body mass index (BMI) was 28.7 kg/cm².

A nasal CPAP titration and therapy was carried out using the device iSleep 20i, “Breas Medical AB”, Sweden, under the supervision of medical staff, and was as follows. A nasal CPAP therapy was begun via face mask, mean pressure was 8 cm H₂O.

A full polysomnography (PSG) was carried out with the use of GRASS-TELEFACTOR Twin PSG (Comet) c As the amplifier 40 with an integrated module for sleep SPM-1 (USA) by standard method.6 ABPM was held using a portable device Oscar 2 system OXFORD Medilog Prima (UK).

A nasal CPAP titration and therapy was carried out using the device iSleep 20i, “Breas Medical AB”, Sweden, under the supervision of medical staff, and was as follows. A nasal CPAP therapy was begun via face mask, mean pressure was 8 cm H₂O. The course of a nasal CPAP therapy consists of 30 sessions during 3 months.

3. Results

PSG analysis performed by the standard method, revealed the presence of moderate-intensity of snoring (snoring index – 106.4 events/h), followed by episodes of apnea/hypopnea (apnea/hypopnea index (AHI) – 16.5 events/hour) and desaturation. The
maximum desaturation was 89% at the initial value — 98–100% with normal breathing. Episodes of apnea/hypopnea with a maximum of up to 30 s. Registered relatively high arousal index (32.6 events/hour at a rate of 16–18 events/hour) associated with episodes of snoring and sleep apnea/hypopnea (Fig. 1). On analysis of sleep histogram, boy was found to be moderately disorganized sleep structure, representation of superficial sleep was 78.5%, slow-wave sleep — 11.5%, sleep with rapid eye movement (REM sleep) — 10% (Fig. 2).

Conclusion: moderate obstructive sleep apnea/hypopnea syndrome.

During ambulance blood pressure monitoring (ABPM), mean systolic and diastolic blood pressure (BP) levels during the night was higher than the 95th percentile for that sex, age and height (138.5 ± 7.7 mmHg and 75.6 ± 3.8 mmHg, accordingly), daily index of systolic BP — 1.2% daily index of diastolic BP — 3.5% (Fig. 3).

Conclusion: Arterial hypertension.

The presence in patient moderate OSA/HS indicated for a nasal CPAP therapy. Adolescent and his parents were informed about a nasal CPAP therapy, contraindications and complications, warned of the consequences of this disease. Consent to a nasal CPAP therapy received.

On the course of a nasal CPAP therapy previously complaints were stopped. There was a trend toward normalization of body weight, BMI was 26.1 kg/m². According to the results re-PSG, the representation of superficial sleep was reduced to 52%, the representation of slow-wave sleep increased to 17.5%, presence of REM sleep — to 20.5%, arousal index was 18.1 events/hour, AHI — 1.2 events/hour, saturation nadir — 95.4% (Fig. 4).

According to the results of repeated ABPM mean systolic and diastolic BP during the night corresponded to standard values for the sex, age and height (114 ± 0.7 mmHg and 63 ± 0.2 mmHg, accordingly), daily index of systolic BP — 13.3%, daily index level of diastolic BP — 18.9% (Fig. 5).

4. Discussion

In recent years, increased attention has received obstructive sleep apnea/hypopnea syndrome (OSA/HS). This syndrome is a condition characterized by the presence of snoring, repetitive partial upper airway obstruction (hypopnea) and/or intermittent complete obstruction (apnea), long enough to cause reduce the level of oxygen in the blood (desaturation), fragmented sleep and excessive daytime sleepiness. The diagnosis of OSA/HS should be made if the episodes of apnea lasting at least 10 s and there are at least 5 times per hour.

In the general population OSA/HS occur in 9% of women and 24% of men, in children and adolescents — 3%.
The most likely causes OSDB in children and adolescents are: adenotonsillar hypertrophy, nasal septum deformity and nasal polyps; craniofacial anomalies (micrognathia, retrognathia, enlarged soft palate, macroglossia). Adenotonsillar hypertrophy reduce clearance of the upper airway, that forces the child to breathe through the mouth, and this leads to a decrease in muscle tone of the throat. The direction of air flow becomes turbulent, which leads to vibration of the soft palate, accompanied by a distinctive sound — snoring and apnea/hypopnea episodes during sleep.8

Sleep disorders in patients with OSA/HS are not only quantitative but also qualitative. Total sleep time is usually reduced not significantly. However, associated with upper airway obstruction arousals lead to serious disturbances in the structure of sleep. Representation of superficial sleep increases markedly, and the duration of slow-wave sleep and REM sleep, in contrast, is

---

**Fig. 2.** Histogram of sleep (hipnogramm). Note: There is excessive fragmentation of sleep, increase the representation of superficial sleep (marked in blue and green colors), shortening of slow-wave sleep (deep blue line) and REM sleep (red line). Gray color indicated periods of wakefulness.

**Fig. 3.** Daily profile of the blood pressure according to ABPM. A – Episodes increase of systolic BP; B – Episodes increase of diastolic BP.
significantly reduced. Such changes in sleep patterns lead to
incomplete restoring of the main functions of the human during the
night, that, in turn leads to the development of various pathological
conditions.

In our patient, during the night of diagnostic PSG, we found the
above-mentioned quantitative and qualitative changes of sleep.

For OSA/HS characterized by the development of hypoxemia,
often combined with hypercapnia, high negative intrathoracic
pressure, increased activity of the sympathetic nervous system
(SNS), repeated arousals, leading to fragmentation of sleep and,
therefore, a change in the normal profile of BP during sleep. A tran-
sient increase in BP observed both in REM sleep and slow-wave
sleep, and the longer the desaturation, the higher the increase of
BP. It is known that 70–90% of middle-aged and older patients with
OSA/HS meets arterial hypertension (AH).4 However, adequate data
are not currently available to support this relationship in children
and adolescents. According to researchers, in adolescents with OSA/
HS observe synchronous changes in pulmonary artery pressure and

![Fig. 4. Full scan 7.5-h recording PSG with hypnogramm after a nasal CPAP therapy. Note: Structure and cycles of sleep, duration of the sleep stages are restored (notation as in Fig. 2), the basic parameters of the relevant age norms1 (AHI — 1.2 events/hour, arousal index — 18.1 events/hour; SaO2 nadir — 95.4%).](image1)

![Fig. 5. Daily profile of the blood pressure according to ABPM after a nasal CPAP therapy. A — Systolic BP level; B — Diastolic BP level.](image2)
heart rate, and the lack of a physiological reduction of BP during sleep ("non-dippers"), moreover, raises of BP observed in the night and early morning hours ("night-piakers") according to ABPM. Repeated hemodynamic fluctuations caused by frequent episodes of apnea/hypopnea, may prevent returning of BP to baseline level, that, in turn, leads to neurohumoral and vascular changes, entailing sustained increase in BP during waking hours and the development of AH in adolescents.9

Thus, we identified in adolescent pattern of sleep-disordered breathing, the cause of which was the presence of adenotonsillar hypertrophy and micrognathia, followed by periodic hypoxemia, in general, explain the presence of excessive brain activity during the night, and, therefore, excessive sleep fragmentation and marked disturbances of its homeostasis. Because of the fragmented sleep significantly increase the tone of the SNS. All these factors, in our opinion, play a decisive role in the forming and stabilization of the AH in this patient.

Major advances in the treatment of patients with OSA/HS is the development of equipment for a nasal continuous positive airway pressure therapy during the night (nasal CPAP).5 It should be noted that in the first night of removing upper airway obstruction in almost all patients BP level normalized or is approximating to normal mark.10 Little is known about nasal CPAP adherence among children and adolescents. In our case, it was shown that nasal CPAP therapy can be used for treatment of OSDB in adolescents, that also leads to the normalization of the circadian profile of BP.

In conclusion, OSA/HS in adolescents is not a rare disease, and is an independent risk factor for AH. Its early diagnostics and adequate treatment of adolescents allow to reduce morbidity and mortality as a result of cardiovascular complications in adulthood.

Conflict of interest statement
The authors state no conflict of interests.

References
1. Guilleminault C, Eldridge F, Dement WC. Insomnia with sleep apnea: a new syndrome. J Sci 1973;181:856–8.
2. Young T. The occurrence of sleep-disordered breathing among middle-aged adults. J N Eng Med 2003;328:1230–5.
3. Krishna J. Urinary protein expression patterns in children with sleep-disordered breathing. J Sleep Med 2006;7:221–7.
4. Fletcher EC. Effect of episodic hypoxia on sympathetic activity and blood pressure. J Respir Phys 2000;119:189–97.
5. White J, Cates C, Wright J. Continuous positive airways pressure for obstructive sleep apnea (cochrane review). In: The cochrane library. Chichester: John Wiley & S; 2004. p. 125–32.
6. Rechtschaffen A, Kales A. Manual of standardized terminology, techniques, and criteria for the scoring of stages of sleep and wakefulness of human subjects. Washington, DL: US Government Printing Office; 1968.
7. Marcus CL, Omlin KJ, Basinki J. Normal polysomnographic values for children and adolescents. J Am Rev Respir Dis 2002;146:1235–9.
8. Battistini A. The tonsils and adenoids as a site of infection and the cause of obstruction. J Pediatr Med Chir 1998;20:237–47.
9. Witmans M. Obstructive apnoea/hypopnoeas in children and adolescents. Am J Respir Crit Care Med 2003;168:1540.
10. Mayer J, Becker H, Brandenburg U. Blood pressure and sleep apnea: results of long-term nasal continuous positive airway pressure therapy. J Cardiol 1991;79:84–92.