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Ambulatory blood pressure monitoring in children with obstructive sleep apnea and primary snoring

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ABSTRACT

Objective: To evaluate the systemic blood pressure (BP) during daytime and nighttime in children with sleep breathing disorders (SBD) and compare parameters of BP in children with diagnosis of obstructive sleep apnea syndrome (OSA) to those one with primary snoring (PS).
Methods: Children, both genders, aged from 8 to 12 years, with symptoms of SBD realized an overnight polysomnography followed by a 24 h recording of ambulatory BP.
Results: All subjects presented with a history of snoring 7 nights per week. Children who have apnea/hipoapnea index $\geq$ four or a apnea index $\geq$ one presented a mean BP of 93 $\pm$7 mmHg and 85 $\pm$9 mmHg diurnal and nocturnal respectively whereas children who have a apnea/hipoapnea $<$ four or a apnea index $<$ one presented 90 $\pm$ 7 mmHg and 77 $\pm$ 2 mmHg. Eight children out of fourteen, from OSA group, lost the physiologic nocturnal dipping of the blood pressure. Among OSA children 57% were considered non-dippers. Two (16%) have presented absence of nocturnal dipping among children with primary snoring. The possibility of OSA children loosing physiologic blood pressure dipping was 6.66 higher than the possibilities of patients from PS group.
Discussion: Our results indicate that children with sleep apnea syndrome exhibit a higher 24 h blood pressure when compared with those of primary snoring in form of decreased degree of nocturnal dipping and increased levels of diastolic and mean blood pressure, according to previous studies in literature. OSA in children seems to be associated to the development of hypertension or other cardiovascular disease.

1. Introduction

The term sleep disordered breathing is used for a spectrum of pathologies related to sleep that involves the increase of resistance or even an alteration of airflow through the upper airways. Such disorders present an increased prevalence in the pediatric population; it is estimated that 3–12% of the children present snoring during sleep [1], in some studies reaches rates as high as 27% [2]. Obstructive sleep apnea (OSA) is characterized by repetitive episodes of upper airway obstruction, usually associated to haemoglobin dessaturation due to a partial or total interruption of respiratory flow. Its prevalence in children vary from 0.7% to 3% [3]. The peak incidence is observed in preschoolers, when obstruction is more common due to the hypertrophy of palatine and pharyngeal tonsils [4]. Besides snoring, there are other symptoms such as mouth breathing, respiratory pauses, breathing difficulty, restless sleep, sweating, nocturnal enuresis and neurocognitive disorders [5–7]. OSA was firstly described in children in 1976 by Guilleminault et al. [8]. It is related to acute and chronic effects on the cardiovascular system [9] such as extreme systemic and pulmonary blood pressure oscillation, cardiac injury associated with repetitive episodes of apnea and hypoxemia [10,11] and cor pulmonale [12–14]. The association between OSA in adults and increased cardiovascular morbidity is well known [15,16]. But there are few pediatric studies that associate the presence of upper airway obstruction due to tonsillar hypertrophy to effects on systemic diurnal and nocturnal blood pressure, presenting divergent results [17–21].

Abbreviations: ABPM, ambulatory blood pressure measurement; AHI, apnea hipopnea index; AI, apnea index; AT, adenotonsillectomy; BMI, body mass index; BP, blood pressure; DBP, diastolic blood pressure; HBP, hypertension blood pressure; HR, heart rate; MBP, mean blood pressure; OSAS, obstructive sleep apnea syndrome; PS, primary snoring; REM, rapid eye movement; SBD, sleep breathing disorder; SBP, systolic blood pressure.

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Enright et al. [17], evaluated the incidence of high blood pressure (BP) in 239 Caucasian and Hispanic children and the possible risk factors. They observed an association to obesity, loud snoring, apnea hipopnea index (AHI) >2 n/h, a lower sleep efficiency and a high arousal index, similar to the cardiopulmonary repercussions of OSA found in adults. Kohyama et al.[18] studied the relation between systemic BP in children with adenotonsillar hypertrophy and the polysomnographic diagnosis of OSA. Moreover, a significant elevation in systolic and diastolic BP with AHI >10 n/h was observed. The authors suggested that OSA may be a risk factor for hypertension, with a positive correlation to the severity of OSA. Similar results were observed by Amin et al. [19] who showed a 24 h blood pressure dysregulation, associated to severity of OSA, oxygen saturation and arousal index. Li et al. [20] demonstrated a dose-dependent association between obstructive breathing disorders in pre-adolescent children and the elevation of diurnal and nocturnal blood pressure. They showed BP changes and decreased nocturnal BP dipping even in children who present primary snoring. Hypertension and earlier stages of abnormal blood pressure control as decreased nocturnal dipping may play a role in the pathogenesis of end organ damage and cardiovascular morbidity, even in children [21]. Early identification and diagnosis of risk factors are important as several studies suggest that individuals who present altered tension levels during childhood may have higher risks of developing systemic hypertension in adulthood, as well as the metabolic syndrome [22].

The aim of the present study is to evaluate the systemic blood pressure during daytime and nighttime in children with obstructive breathing disorders and compare parameters of blood pressure in children with diagnosis of sleep apnea syndrome to those ones with primary snoring.

2. Methods

The present study was approved by the local Ethics Committee (protocol 65/2007). All parents/legal guardians of each child signed a written consent. Exams of polysomnography, ambulatory blood pressure monitoring and nasofibroscopy in children without respiratory complaints were not authorized by the local Ethics Committee.

Children were invited from the Sleep Disorders Ambulatory of Botucatu Medical School, State University of São Paulo-Brazil. Such subjects, both genders and aged between eight and twelve years, were referred due to complaints about obstructive breathing disorders during sleep, characterized by snoring for more than four days a week, with or without observed respiratory pauses and/or restless sleep. All children were submitted to a complete ENT examination, including nasofibroscopy for evaluation of the palatine and pharyngeal tonsillae. An obstruction of 75% or more of the nasopharynx by adenoid tissue and/or hypertrophy of palatine tonsils with a reduction of 75% of the oropharynx area (level III of Brodsky [23]) was considered as a surgical indication.

We excluded children already submitted to adenotonsillectomy, with diagnosis of systemic blood pressure, nephropathy, pulmonary disease, neurological syndrome or use of medication that could interfere in the tension levels or in the parameters of polysomnography, such as diuretics, beta-agonists and sedatives.

Demographic data such as age, gender, height and weight were obtained. For a suitable comparison between different age groups, the body mass index was converted to BMI_z score and the children with BMI_z score over 1.96, corresponding to 95%, were considered obese.

Overnight polysomnography was performed in a sleep laboratory, according to the norms and standards of American Thoracic Society [24], using the computerized Alice 3 ® (Respironics, Pennsylvania, USA), without sedatives or sleep deprivation and registering the following data: index of respiratory events (apnea and hypopnea), arousal index, index of average saturation and oxygen nadir.

Obstructive sleep apnea was defined as the absence of airflow or reduction over 80% of the flow previously registered, greater than or equal to two breaths cycles, with preserved thoraco-abdominal movements. Hypopnea was considered as a partial interruption of the airflow between 50–80% of the respiratory volume previously registered, associated to the fall of oxygen saturation in 3% or arousal. AHI is obtained by the division of the number of respiratory events by the number of slept hours, characterized to the polysomnography by the total number of hours slept (TTS).

The subjects were divided in two groups according to the polysomnographic diagnosis of OSA [25] where the group called "primary snoring" (PS) presented AHI less than 4 or apnea index (AI) <1, and group OSA, presenting AHI $\geq$ 4 or AI $\geq$ 1.

All children were submitted to a 24 h ambulatory systemic blood pressure monitoring (ABPM), considered the method of choice for the diagnosis of BP variability and systemic hypertension. The monitor was programmed to measure the blood pressure every 15 min during the day and every 30 min during the night, with an adequate cuff for arm size and put around the non-dominant arm. The readings were divided into BP during wakefulness and BP during sleep on the basis of the information acquired from the sleep diary. The study was considered adequate when a minimum of 70% of the measurements were obtained without errors. There were registered heart rate, systolic, diastolic, medium, nocturnal and diurnal pressure levels, as well as the decrease of the pressure levels during sleep. The physiological decrease of blood pressure during sleep was defined as the drop of 10% in the medium pressure levels. Children who presented this pattern were considered as dippers. Diurnal and nocturnal hypertensive peaks were considered when observed transient elevations of blood pressure above the 95th percentile for age.

The monitoring was performed on a different day from the day of polysomnography. All the ABPM exams were analyzed by a qualified nephrologist, blinded to the polysomnographic results. All results were expressed as mean $\pm$ standard deviation (SD).

The homogeneity between the groups relating to gender, age and BMI was checked by Fisher's exact test, Mann–Whitney and Students' *t*-test for independent samples, respectively. Multiple regression analysis was performed to identify demographic and polysomnographic factors that might predict variability of BP and nocturnal BP dipping. Statistic significance was considered at $p < 0.05$.

3. Results

Twenty-six children, 19 male, aged 8–12 years old, were included. Six children presented BMI_z score over 95% and were considered obese. Fourteen children who presented AHI $\geq$ 4 and/or AI $\geq$ 1, were allocated in OSA group, whereas twelve children formed the primary snoring group. The distribution of demographic information and polysomnographic results of both groups are demonstrated in Table 1, with no difference between the groups concerning to the age, gender and body mass.

Relating to complaints about obstructive breathing disorders, 80% of the children presented nocturnal snoring, 75% restless sleep and in 50% were observed respiratory pauses.

AHI in children of the primary snoring varied from 0 to 3.09 events/hour, median 0.87 $\pm$ 0.76, while the median AHI in the OSA group was 10 $\pm$ 5.79 events per hour, varying from 2.3 to 23.2. The oxygen saturation in primary snoring group varied from 75 to 100%, but 70 to 99% in OSA group. Among the subjects from OSA group, the lower oxygen saturation value (nadir) was 83.5%, while in primary snoring group the average was 93%.