CASE REPORTS

Clinical analysis of obstructive sleep apnea hypopnea syndrome in children

Xiaoping Sun*, Junfeng Zhao, Yulan Chang, Guifang Cao, Xiaohui Zhang

Department of Otolaryngology, The Third Affiliated Hospital of Inner Mongolia Medical University, Baotou, China

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Abstract

A case of obstructive sleep apnea hypopnea syndrome (OSAHS) in the Department of Otolaryngology of the Third Affiliated Hospital of Inner Mongolia Medical School was collected. The incidence of this disease is high, which seriously threatens the physical and mental health of children, but it has not been paid enough attention by medical workers and parents. We hope we can make early discovery and treatment, relieve upper airway obstruction factors, prevent and treat complications for children with OSAHS through the case analysis, so as to improve their quality of life.

Key Words: Obstructive sleep apnea hypopnea syndrome, Children

1 Medical record

1.1 General information

The 8-year-old patient was admitted to hospital for "snoring during sleep for 2 years" in August 2012. The patient's family found that the child had the symptoms during 2 years, accompanied by loud snoring, and occasionally waking up of unknown origin while they did not take it seriously. The snoring was progressively aggravated, accompanied by daytime sleepiness, and the decline of learning scores. Since the onset of the disease, the patient's conscious was normal. Diet, feces and urine were normal as well.

Past medical history: the patient was always healthy. He had no history of infectious diseases such as hepatitis and tuberculosis, no history of operation, trauma and blood transfusion, no history of drug and food allergy; History of vaccination was not clear.

1.2 Physical examination

T 36.5 °C, P 90 beats/min, R 22/min, BP 105/65 mmHg, height 130 cm, weighing 45 kg, conscious, no systemic superficial lymph node enlargement. It revealed that the pupil size of both eyes was equal and round, and the pupillary reaction to light was normal. There was no deformity of the auricle. Also, there was no abnormal secretion in the external auditory canal. No tenderness in the mastoid region was felt. No abnormalities in the shape of the nose were observed. There were no bleeding and abnormal secretions in the nasal cavity, and no pain in the paranasal sinus area. Cyanotic lip was not observed, and tongue centered, pharyngeal hyperemia, bilateral amygdala in III degree. Hyperemia was not tested, and a small amount of caseous exudation was found in the recess. Double lung breath sounds resonance, and no abnormal breath sound was heard. The heart rate was 90 beats/min, showing regularity in the force and rhythm of the heartbeat. No heart murmurs or arrhythmias were detected by postnatal auscultation. The abdomen was

*Correspondence: Xiaoping Sun; E-mail: dcc55@ncspress.com; Address: Department of Otolaryngology, The Third Affiliated Hospital of Inner Mongolia Medical University, Baotou, China.

flat and soft without gastrointestinal and peristaltic wave, abdominal tenderness nor rebound tenderness and muscle tension. No enlargement of liver, spleen and kidneys beneath the rib was found. Murphy's sign was negative, shifting dullness was positive, bowl sound was normal, without vessel murmur. The muscle strength and muscle tension of the extremities were normal, and there was no edema in the lower limbs.

1.3 Auxiliary examination

Blood routine result: WBC 8.23 $\times$ 10^9/L, RBC 5.68 $\times$ 10^{12}/L, PLT 235 $\times$ 10^9/L, HGB 173 g/L, HCT 50.6, MCV 91.5 fL. Urine routine, stool routine, fecal occult blood showed no obvious abnormalities. The five items of hepatitis B, hepatitis C, syphilis and AIDS were normal. The function of biochemistry and liver was normal. X lateral segment of the nasopharynx showed adenoid hyperplasia (see Figure 1); Fiber nasopharyngeal laryngoscope examination showed that adenoids accounted for 3/4 in the posterior nasal cavity (see Figure 2). Examination of tympanicum in both middle ears showed C type. The binaural stapes muscle reflex was normal; Binaural transient otoacoustic emission: Pass. The average hearing threshold of pure tone audiometry was normal as well. Polysomnography (PSG) showed obstructive apnea index 15 times/h, hypoventilation index 25 times/h, minimum blood oxygen saturation 83%, SaO_2 < 90% cumulative time accounted for 49.6% of total monitoring time, sleep disturbance index (AHI) 17.4 times/h.

Figure 1: Lateral X-rays in nasopharynx

Figure 2: Fiber nasopharyngeal laryngoscope

1.4 Primary diagnosis

Obstructive sleep apnea hypopnea syndrome (OSAHS, moderate level).

1.5 Diagnosis and treatment

After admission to the hospital, the patient showed no obvious surgery and anesthesia contraindications. At the third day, bilateral tonsillectomy and endoscopic adenooid aspiration under the nasal endoscope were performed under general anesthesia. After the operation, anti-inflammation, hemostasis and other symptomatic treatment were given, and the patient was discharged five days after the operation. Fifth days after the operation, the patient and his families stated that nocturnal snoring relieved, and the quality of sleep was obviously improved. After 6 months of follow-up, we were told that the patient enjoyed good sleep at night and was in a good mental state. Moreover, the symptoms of snoring did not occur.

2 Discussion

2.1 Dr. Junfeng Zhao

Dr. Junfeng Zhao is the doctor in the Department of Otolaryngology, Head and Neck Surgery of the Third Affiliated Hospital of Inner Mongolia Medical University, specializing in sleep apnea hypopnea syndrome and audiology.

OSAHS refers to frequent occurrence of upper airway ob-

struction during sleep, which disrupts the normal ventilation and sleep structure and results in a series of pathophysiological changes such as hypoxia and hypercapnia etc.,[1] with the incidence rate of up to 5%-6% in children.[2] An epidemiological survey of sleep status in 28,424 children aged 2-12 years in 8 cities in China shows that the incidence of sleep apnea in children is 0.4%.[3]

According to the literature, there are two peak periods of incidence in the prevalence of OSAHS, and the first peak occurs at the age of 2-8 years. This age group is the proliferative stage of adenoids and tonsils. Magnetic resonance imaging in upper airway showed that the upper airway limitation in OSAHS children was most obvious in the adenoids and tonsils. What's more, the location of the stricture in the adenoids and tonsils was not isolated, but continuous.[4] Mitchell et al.[5] found that the symptoms in the patient were relieved after adenotonsillectomy and the quality of their life improved significantly. So we could conclude that adenoid and tonsil hypertrophy play an important role in the pathogenesis of OSAHS in children. Another peak appears in adolescence, mainly due to weight gain.[6] Obesity is considered to be one of the risk factors of children caused by OSAHS, which may related to upper airway stenosis led by the accumulation of adipose tissue of obese children in the airway muscle and soft tissue (such as hypertrophy of tongue, soft palate, uvula and lateral pharyngeal wall with excessive fat deposition). It may also be in connection with the relatively slow central respiratory regulation system and obesity pulmonary hypoventilation in obese children.

The causes of children's OSAHS also include deviation of nasal septum, nasal polyps, choanal atresia, enlarged tongue, pharynx and nasal swelling, hypertrophy of the soft palate, congenital laryngomalacia, laryngeal web, laryngeal cyst, laryngeal and tracheal neoplasms and tracheal stenosis, micrognathia, Treacher Collins syndrome, Crouson syndrome, Down syndrome, congenital or acquired micrognathia local abnormal anatomy. It is also associated with allergic rhinitis, chronic sinusitis and hypothyroidism.

The patient was at the first peak of OSAHS. He was 8 years old, weighing 45 kg, in height of 130 cm and BMI 26.63g/m^2. Physical examination results indicated that the III degree of bilateral tonsils was large, and the adenoids blocked took up 3/4 of the posterior nasal orifice. Hypertrophy of adenoids and tonsils was the main cause of OSAHS.

2.2 Dr. Xiaohui Zhang

Dr. Xiaohui Zhang is the vice director in the Department of Otolaryngology, Head and Neck Surgery of the Third Affiliated Hospital of Inner Mongolia Medical University, specializing in sleep apnea hypopnea syndrome and audiology.

Due to the stenosis of nasal cavity, nasopharynx, oropharynx or hypopharynx in children with OSAHS, abnormal sleep ventilation occurs and the corresponding clinical symptoms are present. These symptoms vary with age:

(1) Clinical symptoms of 3-12 months: Repeated crying, disturbed sleep, night sweats, snoring and apnea events may occur at night. Symptoms of decreased appetite, growth retardation, and repeated earache due to upper respiratory tract infection may appear during the daily life.

(2) Clinical symptoms of 1-3 years: Discontinuous sleep snoring, night terrors, night sweats, and clear apnea events may occur. Behavioral changes, fatigue, mouth opening breathing, poor appetite, and recurrent respiratory tract infections would present in daily life.

(3) Clinical symptoms of preschool children: Regular severe snoring, mouth breathing, salivation, insanity, awakening, sleepwalking, night terrors, night sweats, abnormal sleep posture, persistent bedwetting at night. Headache in the morning, behavior change, anorexia, stunting, and recurrent upper respiratory tract infection during daily life.

(4) Clinical symptoms of school-age children: Regular severe snoring, abnormal sleep posture, insomnia, delayed sleep phase syndrome, sleepwalking, somniloquy, mouth breathing, salivation and other abnormalities at night. Headache, fatigue, lethargy, abnormal behavior change, learning difficulties, delayed puberty, related tooth problems, recurrent respiratory tract infections, systemic hypertension, right heart failure and other cardiovascular diseases may occur during daily life.

Therefore, a systematic questionaires of the above symptoms must be made to the parents to avoid missed diagnosis if their children are suspected of having OSAHS.

2.3 Dr. Yulan Chang

Dr. Yulan Chang is the chief director and master supervisor in the Department of Otolaryngology, Head and Neck Surgery of the Third Affiliated Hospital of Inner Mongolia Medical University, specializing in nasal science.

Hypoxemia and hypercapnia occur in children with OSAHS because of repeated apnea and hypoventilation at night, which can lead to multiple organ and multisystem complications.

(1) Growth retardation. Growth retardation is a common complication of OSAHS in children. At present, many studies use the situation before and after the treatment of OSAHS to describe the development and treatment effect of children before treatment. Nieminen et al.[7] found that there were no significant differences in body weight and height between OSAHS children and normal controls, but the values were significantly increased 6 months after surgery. They believed that long-term sleep disorders in children with OSAHS caused insufficient growth hormone secretion, resulting in physical retardation. A study

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at abroad showed that there were significant differences in height between OSAHS children and non-OSAHS children: The difference was 1.42 cm at 4 years old, 1.68 cm at 5 years old, 2.17 cm at 6 years old, 3.28 cm at 7 years old, 3.43 cm at 8 years old, and 3.99 cm at 9 years old.

(2) Craniofacial deformity. The craniofacial growth after birth is almost the same as that of the body, but there is a great difference in the speed of craniofacial development in different periods. The skull develops to 90% of the adult volume at the age of 6, while the face is still immature at this time. No matter when OSAHS appears during the period of childhood, its craniofacial development will be affected. Long-term mouth opening can cause "adenoid appearance" in children with OSAHS, which is characterized by an increase in facial height especially the posterior part, the posterior retraction of the mandible, the protrusion of the anterior teeth, the retraction of the lower anterior teeth, and the movement of the hyoid bone, and the retraction of the tongue with the decrease of the skull angle. Wei YH et al.[8] used to study the craniofacial and pharyngeal morphological characteristics of 7 children with OSAHS at the mixed dentition by computer assisted cephalometric technique, and compared with normal children. The main differences of OSAHS patients were shown as follows: Longer dimension of cranial base, larger angle of palate plane and mandibular plane, increased height of tongue, inferiorly displaced hyoid bone, decreased sagittal dimension of upper airway in soft palate level and tongue base level. In addition, the tongue and soft palate occupied a larger proportion of the oropharyngeal area. Therefore, OSAHS may lead to a series of abnormal craniofacial development in children.

(3) Cognitive impairment. The cognitive process is embodied in the ability of children to understand and learn from the environment. Stewart et al.[9] compared the data of the general quality of life in 39 OSAHS children and 391 healthy children. Among the 12 data, 8 items were statistically significant, including limited social activities, behavioral and emotional abnormalities. Kurna et al.[10] performed a series of neurocognitive functional tests on 121 children with OSAHS and 104 healthy children. A variety of neurocognitive dysfunctions were found in children with OSAHS. The 6-9 years old group was characterized by poor memory, poor concentration, poor learning ability, language dysfunction, decreased sensory motor integration ability and perceptual ability, while the 10-13 years old group was mainly characterized by poor memory and poor learning ability.

(4) Cardiovascular diseases. Compared with adult patients, children with OSAHS were manifested as hypoxemia, hypercapnia, pulmonary hypertension and their complications, with less cardiovascular performance, arrhythmia and hypertension were even rare. Leung et al.[11] measured a 24 h-ambulatory blood pressure in 96 children. It was found that compared with the control group, the OSAHS group had significantly higher systolic blood pressure and diastolic blood pressure than those in the control group, while the systolic blood pressure in awake group was significantly higher than that in the control group.

(5) Middle ear diseases. Some of the children are diagnosed with hearing impairment. Due to adenoid hyperplasia, the ostium pharyngeum tubae auditivae of nasopharyngeal lateral wall is blocked, the middle ear forms a negative pressure, leading to the middle ear effusion, that is, exudative otitis media. Some children have not got enough attention and timely treatment in childhood, which results in irreversible hearing loss.

(6) Immune function damage. The immune function of the OSAHS children has different degrees of damage, especially the cell and humoral immune function involved in the leukocyte system.[12] T cells are differentiated from lymphoid stem cells in the thymus and are the most abundant and most complex type of cells in lymphocytes. Though T cells do not produce antibodies, the immune function of T cells is called "cellular immunity" since it directly impose effects on the antibodies. It is generally believed that the unresponsiveness of the healthy people to the irritation of the allergen mainly depends on the establishment of the tolerance of the peripheral T cells. The effects of B cells act through producing antibodies, which exist in the body fluids, so the immune action of B cells is called "humoral immunity". Both T cells and B cells play an important role in cellular immunity and humoral immunity. Meanwhile, the two have important interactions in the whole body's immune system. All kinds of immune responses in the body, whether cell immunity or humoral solution, constitute a very fine, complex and perfect defense system. Qun H et al.[13] showed that OSAHS could seriously affect the immune function of children, both cellular and humoral immunity were impaired. Therefore, it is necessary to take effective medication and/or surgical intervention according to the length and the severity of illness, combined with the symptoms of children, so as to ensure the healthy growth of children, once OSAHS is diagnosed.

2.4 Dr. Guifang Cao

Dr. Guifang Cao is the chief director in the Department of Otolaryngology, Head and Neck Surgery of the Third Affiliated Hospital of Inner Mongolia Medical University, specializing in sleep apnea hypopnea syndrome.

Detailed history and comprehensive physical examination are key to the diagnosis of OSAHS in children. Physical examination and auxiliary examination can make the diagnosis if the children have the symptoms of snoring, mouth breathing, shortness of breath and other medical history for 3 months. Nasopharyngeal lateral X-ray/CT scan and fiberoptic bronchoscopy are able to discover whether there is upper airway obstruction, and the location and ex-

tent of obstruction as the initial diagnosis of OSAHS. However, the definite diagnosis of OSAHS requires monitoring of polysomnography (PSG) throughout the night.

Since 1980s, PSG has been used as a "gold standard" for the diagnosis of sleep disordered breathing. PSG in the night can be applied to children of any age. PSG is helpful to differentiate primary snoring (PS) and OSAHS, and to confirm the diagnosis of OSAHS.[14] PSG can also be used to prevent the risk factors for adverse respiratory events after surgery, including apnea hypopnea index, body mass index and minimum oxygen saturation, etc.[15] It plays an important role in the diagnosis of OSAHS in children.

PSG monitoring is a 7-8 hour night sleep monitoring for children. Obstructive sleep apnea and hypoventilation (the nasal airflow stops, chest and abdominal movement exists) decreased by more than 50% over 6 seconds, with more than 0.03 of oxygen desaturation and/or arousal, would be recorded as a respiratory disturbance event. It is abnormal when apnea hypopna index (AHI) > 5 and/or apnea index (AI) > 1 each hour. Hypoxemia is considered to occur when the minimum blood oxygen saturation < 92%. The snoring not up to the standards above without hypoxemia is diagnosed as PS. Manual analysis is used for the monitoring results. The grading levels of children's OSAHS in China are as follows: Mild degree: AHI 5-10 times/h or AI 1-5 times/h, $LSaO_2$ 0.85-0.91; Moderate degree: AHI 11-20 times/h, or AI 6-10 times/h, $LSaO_2$ 0.75-0.84; Severe degree: AHI > 20 times/h or AI > 10 times/h, $LSaO_2$ < 0.75. At present, the diagnostic criteria of children OSAHS and the clinical significance of AHI classification are not uniform. Many studies use AHI $\geq$ 5 times/h as the clinical boundaries, while studies which support the classification are few.[16]

The results of polysomnography (PSG) showed that: AI 15 times/h, the hypoventilation index 25 times/h, $LSaO_2$c 83.0%, SaO_2 < 90% accounted for 49.6% of the total monitoring time, AHI 17.4 times/h. According to the clinical symptoms, signs and PSG monitoring, the diagnosis of OSAHS (moderate) was confirmed.

2.5 Dr. Xiaoping Sun

Dr. Xiaoping Sun is the chief director and master supervisor in the Department of Otolaryngology, Head and Neck Surgery of the Third Affiliated Hospital of Inner Mongolia Medical University, specializing in sleep apnea hypopnea syndrome.

Early detection and rational and effective treatment can not only alleviate or completely alleviate snoring, sleep apnea and other symptoms, but also control or cure OSAHS induced multisystem complications, and improve the quality of life of children, despite the high prevalence of OSAHS in children with more complications and health hazards.

At present, it is generally accepted that adenoid and tonsil hypertrophy are the most common and major causes of OSAHS in children. Surgical resection can relieve the obstruction of upper airway and restore airway patency. So tonsillectomy and adenoid surgery have been considered as the most common methods of OSAHS in children,[17] and the cure rate is 75%-100%.[18] The surgical methods include adenoidectomy under nasal endoscope electric suction, tonsillectomy, microwave, low-temperature plasma ablation, electrocautery, intracapsular tonsillectomy and suction cutting cobalt. Traditional tonsillectomy and curettage of adenoids have gradually been replaced by new technologies due to many complications caused by the surgery, such as bleeding, likely to carry residue and easy to damage surrounding tissues. Microwave partial tonsillectomy is especially suitable for simple tonsil hyperplasia or physiological hypertrophy of OSAHS in children, which not only partly removes tonsils, but also retains a part of normal tonsil tissue, so as to retain the complete immune system and function of children.[19]

Continuous positive airway pressure (CPAP) treatment is especially suitable for the patients who have contraindications to surgery, persistent symptoms after tonsillectomy, and who do not wish to undergo surgical treatment. CPAP refers to the mode of ventilation with positive pressure during the whole respiratory cycle under the condition that the patient has enough spontaneous breathing. CPAP is considered to be the most effective treatment for non-surgical treatment of OSAHS. About 78% of children with CPAP have achieved ideal therapeutic effects. With the advent of family CPAP, it is more convenient for patients to use and avoid tracheotomy.

There are also some adjuvant therapies available: (1) Oral appliances: For children who are inoperable and intolerant of CPAP. It can be used for the treatment of mild and moderate OSAHS in children with mandibular advancement appliance. (2) Anti-inflammatory therapy: The pathogenesis of OSAHS is mediated by inflammation, which has been widely recognized. Intranasal corticosteroids and leukotriene receptor antagonists are effective in improving mild OSAHS induced by adenoidal hypertrophy. (3) Other adjuvant therapies: Including weight loss, active treatment of rhinitis, sinusitis, postural therapy, diet therapy, and so on.

According to the symptoms, signs and PSG monitoring results, the patient was diagnosed as OSAHS (moderate). Therefore, under general anesthesia, bilateral tonsillectomy and nasal endoscopic adenoid electric suction surgery were performed and the surgery was very successful. The patient recovered and discharged after the surgery. Fifth days after the operation, the patients and their families told us that nocturnal sleep snoring was relieved, the quality of sleep improved obviously, and the diet was improved as well. After 6 months of follow-up, we were told that the patient enjoyed

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good sleep at night and was in a good mental state. Moreover, the symptoms of snoring did not occur.

In short, the prevalence of OSAHS is high, which causes great harm to children's health and seriously affects the growth and development of children. Children account for a large population in China. In order to avoid misdiagnosis and missed diagnosis, it is necessary to do a better job of medical science education and clinical work for medical workers and parents. Early screening, detailed inquiry of children's medical history and past signs should be made combined with PSG to develop individualized treatment program, and achieve the goal of early treatment, prevention of complications, and improve the quality of life of children.

Conflicts of Interest Disclosure

The authors have no conflicts of interest related to this article.

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