Case Report

A CASE REPORT OF BULLOUS EMPHYSEMA IN AN ADOLESCENT: CONGENITAL MALFORMATION OR OUTCOME OF BRONCHOPULMONARY DYSPLASIA?

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Abstract: Pulmonary emphysema belongs to the group of chronic obstructive pulmonary diseases, and in pediatric pulmonology is one of the complex diagnoses that require a careful differential diagnosis. The article describes the possible causes of the formation and clinical manifestations of pulmonary emphysema in children. We present a clinical case of bullous emphysema in a teenager. This case shows that a detailed examination using such a modern diagnostic method as high-resolution computed tomography played a crucial role in establishing the patient's correct diagnosis. However, establishing the nature of this pathological process in the child was very difficult. Perhaps an earlier diagnosis could prevent severe irreversible changes in a teenager's lungs would avoid developing the diffuse bronchopulmonary process.

Keywords: bullous emphysema, congenital malformation, bronchopulmonary dysplasia, children.

INTRODUCTION One of the most difficult differential diagnoses in pediatric practice is lung pathology, accompanied by increased lung tissue transparency syndrome. In children, this syndrome most often occurs in severe bronchial asthma. Still, it may also be a sign of pulmonary emphysema (PE) - one of the most severe forms of chronic obstructive lung disease [1].

The reason for the PE may be a genetic predisposition due to hereditary deficiency of elastase inhibitors, such as alpha-1-antitrypsin and alpha-2-macroglobulin. In this case, the lung's elastic carcass is destroyed due to the excessive accumulation of proteolytic enzymes produced mainly by neutrophils and alveolar macrophages. In children, deficiency of alpha-1-antitrypsin is manifested by congenital liver cirrhosis during the newborn period, and chronic obstructive lung disease (emphysema and/or bronchiectasis) is usually formed only after 18 years [2, 3].

The bullous emphysema (BE) is considered a morphological variant of emphysema. It is characterized by the destruction of alveolar walls with the formation of cavities larger than 1.0 cm, called bullae. Their edges are formed by visceral pleura and lobular partitions. PE, accompanied by the formation of many large bullae, is called bullous lung disease [4, 5]. There is not so much epidemiological data on BE in the literature. Still, in general, it is known that BE affects more than 5% of the world population, with a total prevalence of about 12% in adults over 30 years old in the structure of lung pathology. In the United States, BE is in 3rd place among diseases that lead to death and kills more than 120,000 people per year [6].

Congenital lobar emphysema (CLE) is a relatively uncommon congenital lung malformation characterized by severe progressive hyperinflation of one or more pulmonary lobes, compression and collapse of the remaining lung parenchyma, and mediastinal shift to the opposite side. It is an important cause of respiratory distress in the neonatal and infantile period with a high level of mortality and can result in serious morbidity and disability [7]. CLE is a rare lung malformation. Its incidence is 1/20,000–30,000 live

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births. The prenatal incidence is unknown because of diagnostic difficulties with ultrasonography in this period. It is more common in males, and the male to female ratio is 3:1. One-third of cases are symptomatic at birth, and nearly all of them are diagnosed in the first six months of life. The most common observation of this disease is left upper lobe involvement (43%), followed by right middle lobe (32%) and right upper lobe (21%) involvement. Lower lobe involvement (2%) is the rarest form. In the literature, more than one lobe and bilateral involvement have been described [7, 8]. In 50-55% of cases, the cause of the disease cannot be established. Still, it is suggested that CLE can occur because of abnormal development of lobar bronchus (underdevelopment and absence of cartilage elements of bronchi), partial obstruction of the bronchial lumen by thickened folds of the mucous membrane, compression of a lobar bronchus by abnormally departing vessel, and in case of severe lung damage in children of early age [9, 10]. The valve mechanism of bronchial obstruction arising at that leads to a sharp increase of intrapulmonary pressure; an overstrain of the parenchyma of the affected part of the lung and a decrease in lung tissue elasticity, a decrease in the volume of healthy parts of the lung and a shift of the mediastinum to the opposite side.

CLE's main clinical manifestation is respiratory insufficiency (RI), the severity of which depends on the amount of lesion and the degree of compression of healthy lung areas [11]. The most severe forms of CLE manifest in the first minutes and hours of life. Approximately 50% of patients are diagnosed in the first month of life [12]. The disease is less frequently diagnosed in preschool and even high school-age children, who are indicated by frequent respiratory illness, repeated bronchitis, and chest deformity in the form of asymmetry and swelling of the chest wall over the emphysema area [13].

Some scientists consider PE in children as a manifestation of connective tissue dysplasia (CTD). Signs of CTD of the respiratory system are tracheobronchomalacia, tracheobronchomegaly, tracheobronchial dyskinesia, bronchiectasis, apical bulls, and primary spontaneous pneumothorax. There are changes in the osseous-articular system in the form of deformation of the chest (funnel-shaped, keel-shaped), spine (scoliosis, kyphosis), extremities (valgus, varus), feet (flat feet), joint hypermobility [14, 15].

Lung infection can be an important factor in PE development. Infectious inflammation stimulates the proteolytic activity of macrophages and neutrophils. Bacteria may also act as an additional source of proteolytic agents, including elastases. All this leads to the development of protease-antiprotease imbalances. Recently, respiratory viruses have been given considerable importance in PE pathogenesis. Viruses in themselves do not cause a pronounced neutrophil or macrophage reaction. Still, because of their high infectivity and ability to suppress local and general immunity, they, in most cases, contribute to the aggravation of inflammatory processes with the development of bacterial infection [16].

Bronchopulmonary dysplasia (BPD) is another cause of lung emphysema in children. In BPD's pathogenesis, lung tissue's immaturity to the extreme damaging action of peroxide compounds formed during oxygen therapy is crucial. Lung barotrauma due to the toxic action of high concentrations of oxygen in the inhaled mixture leads to damage of epithelial and endothelial cell barriers, and the development of protein-containing pulmonary tissue edema, which is accompanied by a decrease in the extensibility of alveolus, already impaired due to a deficiency of surfactant. The decrease in lung compliance and increasing violations of ventilation-perfusion relations make it necessary to use higher parameters of ALV, which closes a vicious circle, increasing lung damage. The use of ALV with constant positive pressure promotes the alveolus's rupture with interstitial emphysema formation. BPD is currently being studied quite deeply in young children, but catamnestic observations of this pathology's outcome are isolated in adolescence [17, 18].

CASE PRESENTATION This clinical case can serve as an example of the complexity of diagnosis in the case of bullous emphysema syndrome in an adolescent.

A 15-years-old boy was admitted to the pulmonology department in October 2017 with complaints about the shortness of breath, increasing with minimal physical activity, rapid fatigue, frequent bronchitis (up to 3-4 times a year). According to the patient, periodically during coughing and shortness of breath uses inhalation of short-acting beta-2 agonists.

From the previous medical history, the adolescent was born from the third pregnancy with chronic placental insufficiency, bacterial vaginosis, mild anemia; no significant medical history of hereditary disorders or parents' bad habits. The delivery was through the cesarian section at 39-week gestation due to the transverse position of the fetus. The baby was in medium severity asphyxia with a delay of intrauterine development (weight at birth - 2550 g, length

of the body - 47 cm). Respiratory distress syndrome was observed from the first minutes of life, and the child for a long time was on mechanical ventilation. The ventilator settings were: PIP - 30 cm of H2O, PEEP - 4 cm of H2O, FiO2: 0.9. At the age of 3 months, lobar emphysema was diagnosed, and the upper left lobectomy was performed. Subsequently, the child often had bronchitis, which was periodically accompanied by the broncho-obstructive syndrome. At the age of 3 years, based on the disease's history, chronic bronchitis was diagnosed. During the next 14 years, the boy was observed irregularly, the last inpatient examination and treatment at ten years old. Monitoring of spirometric indicators at the outpatient stage was not carried out.

***Objective status*:** The adolescent's general condition was of moderate severity due to respiratory disorders, protein-energy deficiency. Consciousness was clear. The height is 176 cm, the bodyweight is 49.6 kg, BMI is 16.0 kg/m2. Respiratory rate is 24/min; heart rate is 85 beats/min, blood pressure is 90/60 mm Hg. Oxygen saturation is 92 % with room air. Skin and visible mucous membranes were a light pink color. There was no edema, cyanosis, and clubbing. The subcutaneous fat was evenly thinned. Peripheral lymph nodes were not enlarged. The chest was asymmetrical; the left hemithorax was enlarged. Auscultation over the lungs in the lower parts of the left lung breathing was sharply weakened, on the right - evenly carried out in all departments; wheezing was not heard. The percussion sound in the lower parts of the left lung was boxed. Heart tones were loud, rhythmic, and an accent of the II tone over the pulmonary artery. The abdomen was soft and painless on palpation. The liver was at the edge of the costal arch; the spleen was not palpable. Adolescent sexual development is not impaired.

Laboratory and instrumental examination included clinical and biochemical blood tests (without pathological changes). The level of α-1-antitrypsin was 1.15 g/l (N=0.9-2.0 g/l); the content of sweat chlorides was 16 mg/l.

The spirometry showed a mixed severe ventilation disorder with a predominance of obstructive component (FEV1 46.6%, FVC 64.5%, PEF 51% before inhalation of a bronchodilator) with poor bronchodilator reversibility (FEV1 48.5 %, FVC 75.1%, PEF 57.2% after inhalation of a bronchodilator).

On the chest X-ray, deformation of the lung roots, heterogeneity of pneumatization of the pulmonary fields, depletion of the upper lobe's vascular pattern of the left lung, low location, and flattening the dome of the diaphragm were determined.

An electrocardiographic and echocardiographic examination revealed deviations of the heart's electrical axis to the right, signs of pulmonary hypertension of the first degree (SPPA = 35 mm Hg).

A high-resolution computed tomography (HRCT) was included in the examination plan to detail the lung tissue's morphological changes. HRCT revealed multiple areas of panlobular emphysema, emphysematous bullae from 12 to 95 mm in size in the parenchyma of both lungs, but more in the lower lobe of the left lung. The pulmonary pattern was deformed, left depleted. Roots are not extended, sinuses are free. Mediastinum lymph nodes are not enlarged (Figure 1).

According to the complaints, life and medical history, and the complex examination results, the following clinical diagnosis was made: Bilateral bullous emphysema of the lungs. Complications: Chronic pulmonary heart disease. Group III Pulmonary Hypertension. Respiratory failure of II degree. Protein-energy deficiency of II degree.

The adolescent was consulted by a thoracic surgeon, who concluded that surgical treatment is not indicated at that time. The surgeon classified the patient as a risk group for possible pneumothorax and gave recommendations to limit the physical activity.

The presented clinical case shows that an HRCT was crucial in the diagnosis of emphysema in this patient. HRCT has significant advantages in detecting and evaluating the prevalence of pulmonary emphysema as compared to X-ray examination. The main advantage of HRCT is a high sensitivity, exceeding 90%, in detecting even small thin-walled cysts that cannot be seen on radiographs. More accurately than radiography, HRCT transmits morphological changes in the lungs at various forms of emphysema.

Another equally difficult task is to determine the nature of this pathological process. Is the patient's emphysema a primary, independent nosologic unit (congenital malformation) or a secondary one as an outcome of bronchopulmonary dysplasia? The clinical differentiation of these conditions in this patient is very difficult. On the one hand, the severity of the child's general condition at birth, respiratory problems in the first minutes of life, the localization of the primary pathological process in the upper left lung could indicate in favor of congenital lobar emphysema. On the other hand, the development and

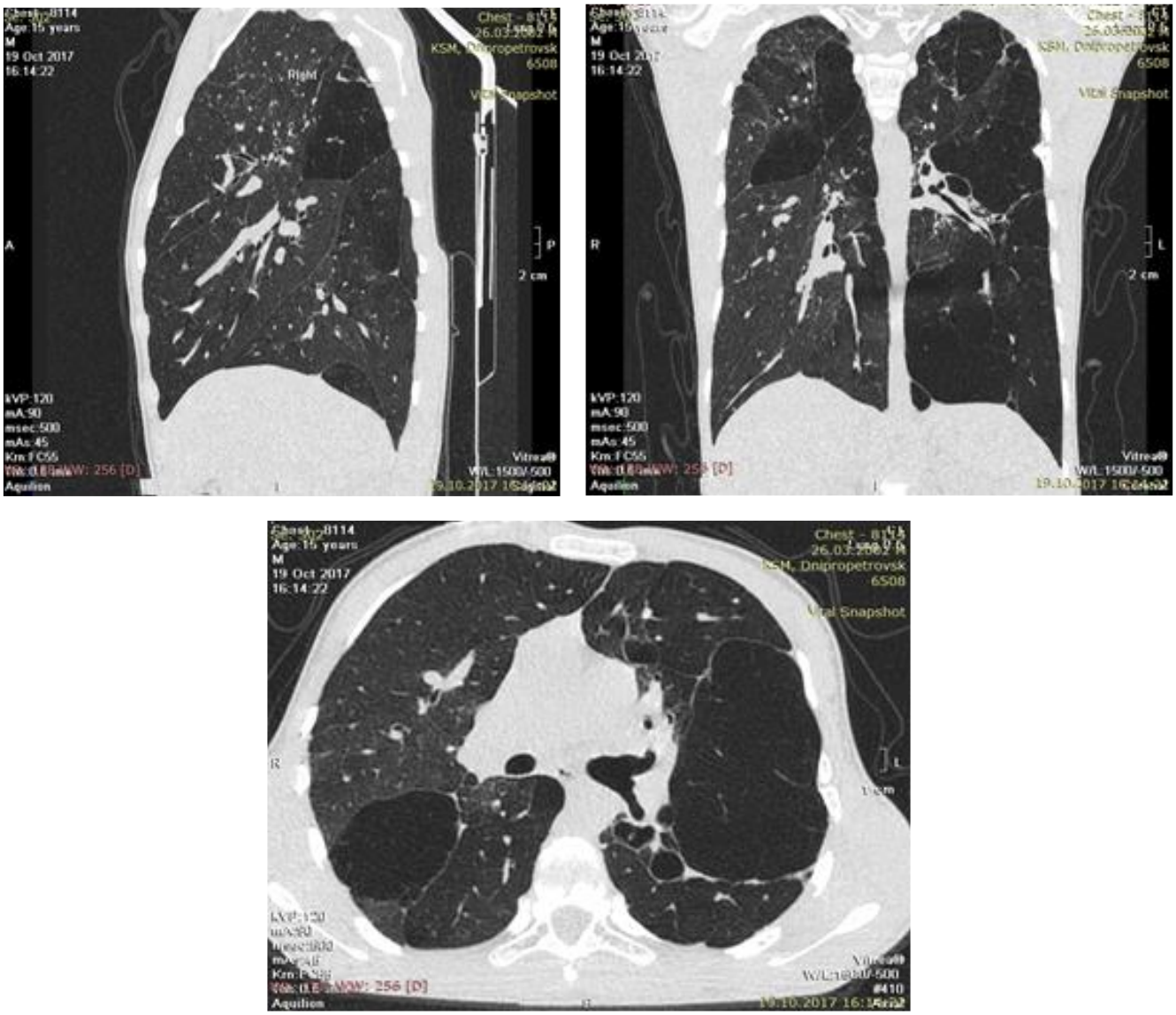

Figure 1. HRCT of the thoracic organs of a 15-years-old boy (multiple areas of panlobular emphysema with the formation of emphysema bullae).

progression of the bullous emphysema may be considered a result of bronchopulmonary dysplasia, evidenced by long oxygenation therapy in the neonatal period, bilateral nature of the pathological process, low birth weight. The aggravating factor was probably the intrauterine infection of the child. To verify the diagnosis in this case, it would be useful to analyze the pathomorphological examination of the biomaterial obtained during a lobectomy, lung biopsy at present, but that is an invasive and inaccessible diagnostic method in pediatric pulmonology because of the high risks of complications.

At discharge from the hospital, the adolescent was given the following recommendations: annual influenza and pneumococcal immunization; correction of nutritional status; limiting the heavy physical activity; control of spirometric parameters every three months; use of bronchodilators if necessary; daily control of SaO2; oxygen therapy with a decrease in SaO2 less than 92%; lung transplantation should be considered if the disease is severe.

CONCLUSION In summary, deep analysis of the patient's medical history from an early age, doctors' records in the primary documentation, and the obtained results of the clinical and instrumental examination in adolescence, the pathological process should be concluded as a case of the diffuse undifferentiated bronchopulmonary process with severe and irreversible disorders of both structure and function of the lungs, the prevention of which should have been carried out at the early stages of the disease, because the child is already from the neonatal period had all criteria. Monitoring of functional and instrumental research data should have been mandatory for the follow-up of such children. HRCT is a highly sensitive pediatric pulmonology method to determine the prevalence and dynamics of pathomorphological disorders in pulmonary airiness syndrome.

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