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Single Lung Acute Respiratory Distress Syndrome

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Abstract

Hydatid disease or echinococcosis is a zoonotic parasitic disease. The lungs are the second most commonly affected organ after the liver. Intrathoracic and extrapulmonary hydatid disease can affect the pleura, mediastinum, heart, diaphragm, and chest wall. The unusual location or complications of thoracic hydatid disease can present both a diagnostic problem and a therapeutic and surgical problem. We present results of a case of multilocular thoracic hydatid disease complicated by aortic wall erosion and cystic fistula in a 23-year-old patient who developed acute respiratory distress syndrome (ARDS) on the 4th day after emergency pneumonectomy. The surgery was carried out under the conditions of the auxiliary artificial circulation. This case represented a serious clinical situation with the highest risk to life. The need for immediate respiratory support was due to the development of severe respiratory failure, and the presence of direct and indirect harmful factors of ARDS. The correct choice of modes and techniques of mechanical ventilation resulted in significant and sustained improvement in gas exchange parameters without hemodynamic disorders with a further favorable outcome.

Keywords

Hydatid Disease of the Lung, Hemorrhagic Shock, Pneumonectomy, Acute Respiratory Distress Syndrome

1. Introduction

Hydatid disease or echinococcosis is a zoonotic parasitic disease. Central Asia is an endemic region for echinococcosis—the level of damage to the population is 6 - 9 per 100,000 population [1] [2].

The frequency of rare localizations of echinococcosis ranges from 1% to 7%, and often these patients are operated on under various diagnoses, and echinococcosis is established only intraoperatively [3].

The lungs are the second most commonly affected organ after the liver. Intrathoracic and extrapulmonary hydatid disease can affect the pleura, mediastinum, heart, diaphragm, and chest wall.

The problem of echinococcosis, despite the progress made in diagnosis and treatment, remains very relevant to this day. There is an increase in complicated cases of human echinococcal disease.

The most serious issues that the surgeon faces during the preparation and performance of surgery for echinococcosis of the thoracic cavity are the accurate topical diagnosis of the cyst and the determination of adequate access and methods for eliminating the residual cavity [4].

Thus, the diagnosis, surgical treatment and postoperative intensive care of mediastinal echinococcosis is extremely difficult. A special place is occupied by the issue of differential diagnosis between tumors and cysts of the mediastinum, on the one hand, and aortic aneurysms, on the other.

The unusual location or complications of thoracic hydatid disease can present both a diagnostic problem and a therapeutic and surgical problem.

We present results of a case of multilocular thoracic hydatid disease complicated by aortic wall erosion and cystic fistula in a 23-year-old patient who developed acute respiratory distress syndrome (ARDS) on the 4th day after emergency pneumonectomy.

2. Case Presentation

Patient I.F., 23 years old, was admitted to the Lung and Mediastinal Surgery Department of the Republican Specialized Center for Surgery named after academician V. Vakhidov with a preliminary diagnosis of recurrent multiple echinococcosis of both lungs, complicated by profuse pulmonary hemorrhage.

Chest x-ray revealed rounded shading in the upper lung field on the left. To verify the diagnosis, chest CT-scanning was performed (**Figure 1**), on which, in the projection of the upper lobe bronchus of the left lung, an irregularly shaped multinodular volumetric formation, with fuzzy, uneven contours, of a homogeneous structure, 5.0 × 6.5 × 6.5 see also in both lungs parenchymal and subpleurally determined multiple regular shape rounded shadows, having a connection with the root of the lung.

The planned CT angiography could not be performed, because in the period of preparation for the study there was repeated profuse pulmonary bleeding.

The patient was urgently hospitalized in the intensive care unit, where fiberoptic bronchoscopy was performed under local anesthesia. At the same time, in the lumen of the left main bronchus, a blood clot was determined, completely obturating the bronchus. The blood clot was tightly fixed; it was not removed during bronchial lavage.

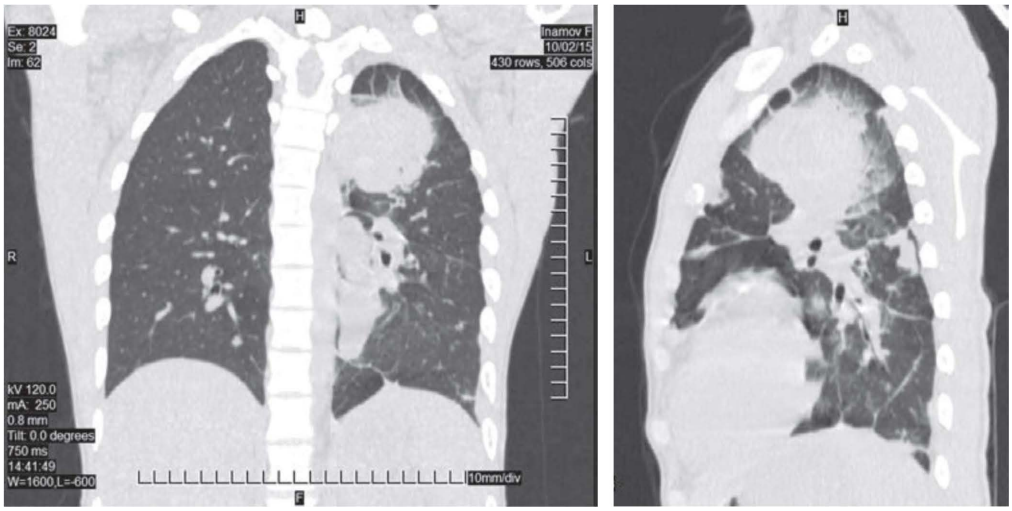

Figure 1. Preoperative CT-scanning data. 3D reconstruction in direct and lateral projection. Volumetric multinodular formation of the upper lobe. Multiple masses in both lungs.

Thus, the patient had initial morphological and functional disorders of external respiration, was operated on with a diagnosis of echinococcal cyst of the left lung, complicated by suppuration and a breakthrough in the bronchus, aortocystic fistula on the left, complicated by profuse pulmonary bleeding.

Surgical intervention (pneumonectomy, suturing of the defect in the wall of the aortic arch) was performed under conditions of artificial circulation (140 min).

A skin incision 10 cm long in the left inguinal region cut the skin, subcutaneous fat, fascia, exposed the left femoral vein. Performed cannulation of the left femoral artery and vein. The cannulas were fixed. After reducing the wound on the thigh, a lateral thoracotomy was performed in the IV intercostal space on the left with a skin incision up to 20 cm long.

The pleural cavity was opened. The pleural cavity was completely obliterated. Pneumolysis began in a blunt and acute way. In the course of isolation, several echinococcal cysts were removed from the pleural cavity. Performed pneumolysis of the mediastinal surface of the lung. The anterior surface of the pericardium was exposed, and several echinococcal cysts were also removed from the pericardium. The lung was imbibed with blood, resembling a liver.

The area of the lung root is also tightly fused; it was not possible to differentiate the elements of the lung root. The phrenic nerve was also in the adhesive process. The pericardial cavity was opened. The left pulmonary artery and the superior and inferior pulmonary veins were isolated intrapericardially, ligated, sutured, and transected. An echinococcal cyst was opened along the posterolateral surface of the pericardium. Chitinous membranes were removed, thick purulent contents were evacuated. We continued to isolate the remaining part of the lung. At the same time, an echinococcal cyst of the upper lobe was opened, after which the chitinous membranes with blood clots were removed. At this moment, massive profuse bleeding from the cyst cavity opened. Bleeding is

stopped by finger pressure. It was established that the bottom of the cyst cavity communicated with the lumen of the aorta. Artificial circulation was started. A forced decision was made to perform a pneumonectomy.

The lung was resected using the fragmentation method to create access to the aorta above and below the level of the defect. The descending aorta was isolated immediately after the left subclavian artery originated and below the level of the lung root. Above and below the level of the defect, the aorta was clamped. The size of the defect on the aortic wall was about 13 × 14 × 15 mm. The aortic defect was sutured with atraumatic interrupted sutures. The second layer was applied with a continuous twisting seam. The area of the sutured defect was covered with the third row of U-shaped sutures. The clamps on the aorta were removed. The bleeding has been stopped. The left main bronchus was crossed at the bifurcation. Interrupted atraumatic sutures were placed on the bronchus stump. The remaining fragments of the lung, soldered to the surface of the diaphragm, were removed from the osseophrenic sinus, as well as from the pericardium.

A large blood loss (3.0 l) required an appropriate transfusion of blood components during and after surgery.

In the intensive care unit after 3 days, the patient regained adequate spontaneous breathing and was disconnected from artificial lung ventilation. On the 4th day, severe ARDS developed. Chest radiography revealed infiltrative, heterogeneous, cloud-like opacities covering the upper, middle, and lower sections of the right lung with small areas of preserved pneumatization (**Figure 2**). Oxygenation index—0.8. Analysis of blood gases from the artery: PaO_2—50 mmHg, pCO_2—48.5 mmHg. Assessment of the severity of lung damage by Murray—2.75. The condition was regarded as postpneumonectomy ARDS, which developed against the background of bleeding, hemorrhagic shock, massive blood transfusion and cardiopulmonary bypass. The nature and severity of the parenchymal lesion corresponded to severe ARDS with a poor prognosis.

Mechanical ventilation was started in the Pressure control ventilation mode using a "step-by-step" increase in Pressure control (P-control) and Positive end-expiratory pressure (PEEP). Respiratory support continued with the following parameters: P-control—30 cm of water. Art., PEEP—14 cmH_2O, I:E (inspiratory and expiratory time ratio)—1.5:1, FiO_2 (fraction of inspired oxygen)—50%. Positive dynamics was registered by the end of 5 days, PaO_2 (partial pressure of oxygen in arterial blood) and PaO_2/FiO_2 ratio (oxygenation index) increased by 2 times. From the 6th day there was a stable compensation of the process. This allowed a gradual decrease in FiO_2 to begin.

On the 8th day, significantly better calculated indicators and indices were noted than on the 4th day. PaO_2 and paO_2/FiO_2 continued to rise. On the 14th day after the operation, the patient was disconnected from the ventilator with the restoration of spontaneous respiration and normal parameters of gas exchange and the acid-base state of the blood.

On the 37th day after the operation, the patient was discharged in a satisfactory

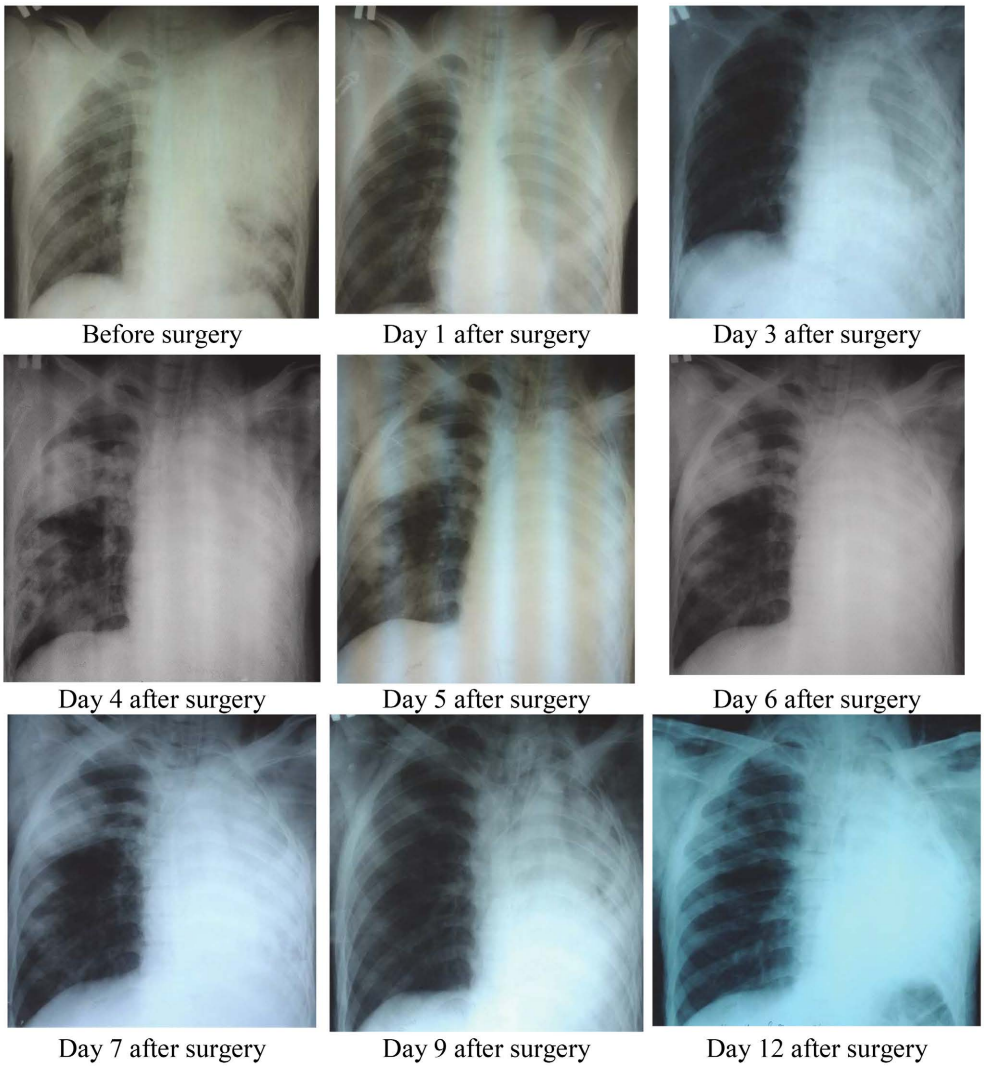

Figure 2. Chest radiography dynamics.

condition for outpatient observation, where chemotherapy with albendazole was prescribed due to the presence of the remaining two echinococcal cysts in the only right lung, as well as to prevent recurrence and dissemination of echinococcosis.

3. Discussion

Pneumonectomy is a complicated procedure associated with high morbidity and mortality. A significant decrease in lung tissue volume is accompanied by pronounced anatomical and physiological changes, which increases the risk of dangerous intra- and postoperative complications. Postpneumonectomy pulmonary edema occurs in 2% to 5% of cases and typically presents on postoperative days 2 to 3. At the same time, severe violations of lung biomechanics, gas exchange, critical hypoxemia develop, which are the causes of hypoxia, multiple organ failure, and deaths (up to 50%) and require complex treatment [4].

As a rule, radiological changes lag behind clinical signs in time of appearance

and may be partly hidden due to hyperinflation of the remaining lung. In the presented clinical case, postpneumonectomy pulmonary edema was considered as a variant of acute respiratory distress syndrome (ARDS) [5]. We observed signs of severe blood loss, hemorrhagic shock, hemothorax against the background of already existing morphological and functional respiratory disorders that developed as a result of the underlying disease (pulmonary echinococcosis). Emergency surgery (pneumonectomy, suturing of a defect in the wall of the aortic arch) was performed under artificial circulation and was accompanied by significant blood loss with hemodynamic disturbances in the intra- and postoperative period.

Currently, there is no specific treatment for ARDS, since there are no effective methods for correcting pathological vascular permeability and inflammation in patients with this pathology. Therefore, therapy is aimed at optimizing the oxygen balance in the body and treating the underlying pathology. In this regard, respiratory support occupies a leading place in the treatment of ARDS as a method of temporary prosthetics for the function of external respiration. An acute problem, in our opinion, is the choice of optimal respiratory tactics in the development of ARDS in a single lung.

In mechanically ventilated patients with ARDS, regulation of the set PEEP remains the most effective way to control blood oxygenation in the lungs [5]. The main "therapeutic target" of PEEP is unstable and collapsed alveoli. The mobilization of damaged alveoli determines not only the effectiveness of improving biomechanics and gas exchange, but also the prognosis of the subsequent restoration of lung function. In clinical practice, it is important to determine what level of PEEP and what method of its selection are optimal in a particular patient.

Our patient was administered albendazole for 12 weeks postoperatively. During therapy, the patient did not experience any side effects of the drug. Liver function was normal. Serological analyzes did not reveal signs of echinococcosis. Also, instrumental diagnostic methods did not reveal other organs of the lesion.

Previously, we have already presented the results of diagnosis and treatment of this case [6] [7]. In this article, we also wanted to share more recent results from this rare case of single lung ARDS with multiple direct and indirect injury factors. So, the figures below show the results of a CT-scan of the mediastinal organs (**Figure 3**).

4. Conclusions

In the presented clinical case of ARDS of the solitary lung, the well-coordinated work of the team of thoracic and cardiac surgeons, the predicted risk of intraoperative massive bleeding made it possible to plan intraoperative tactics, start the operation with cannulation of the vessels and timely connect the heart-lung machine, which created conditions for aortic clamping, elimination of the aortic defect and stopping the profuse bleeding.

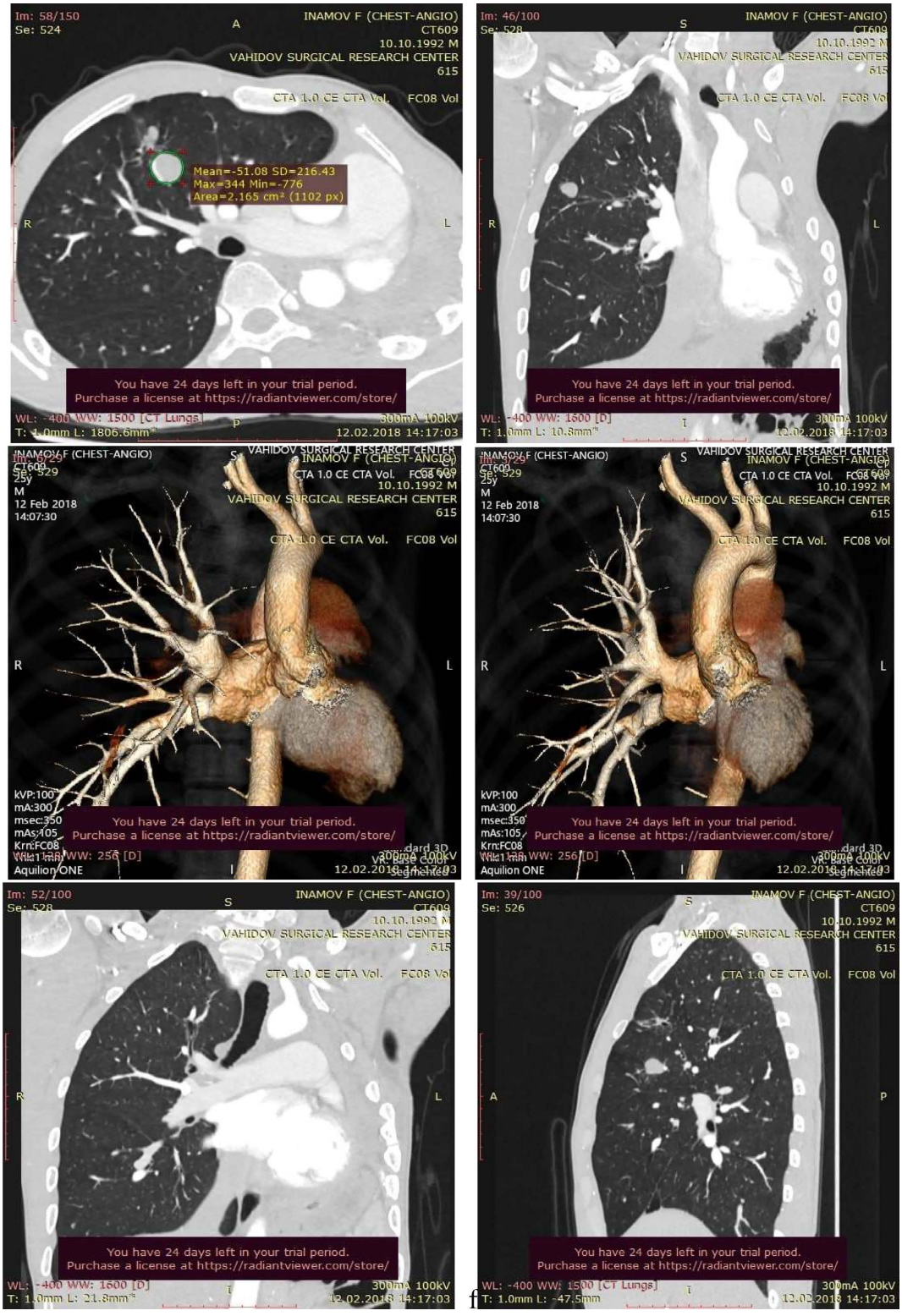

Figure 3. Chest CT-scanning data 2.5 years after surgery.

Competently performed anesthesia, as well as a complex of intensive care in the early postoperative period, made it possible to stop severe complications from the only lung that arose as a result of exposure to direct and indirect da-

maging factors (posthemorrhagic, postperfusion and posttransfusion). The effectiveness of using the technique of "step-by-step" increase in Pcontrol and PEEP, in accordance with the concepts of "safe mechanical ventilation", is shown, confirmed by a progressive increase in PaO_2/FiO_2, in the absence of negative respiratory and circulatory effects.

Data Availability

The data are available on request by contacting the corresponding author.

Consent

Written informed consent for publication was obtained from the patient.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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