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CLINICAL CASE REPORTS

OPTIMIZATION OF ANESTHETIC TACTICS IN THE SURGICAL TREATMENT OF MULTIPLE PRIMARY NON-SMALL CELL LUNG CANCER

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ABSTRACT

The article describes a clinical case of surgical treatment of a patient with multiple primary malignant lesions of the lungs (cancer of the left lung, central peribronchial nodular tumor with involvement of the upper lobe and distal parts of the main bronchus; cancer of the right lung, central tumor with involvement of the upper lobar bronchus). Radical treatment became possible due to using the potential of artificial gas exchange of both lungs with two devices with fundamentally different ventilation mechanics. The choice of an optimal tactics for the functional correction of the supposed hypoxemia by volumetric and high-frequency pulmonary ventilation allowed avoiding an imbalance in the ventilation/perfusion ratio and preventing the development of life-threatening complications, as well as ensured an adequate gas exchange for the patient during surgical treatment.

Keywords:
multiple primary cancer, lung cancer, surgical treatment, lobectomy, artificial lung ventilation, gas exchange.

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КЛИНИЧЕСКОЕ НАБЛЮДЕНИЕ

ОПТИМИЗАЦИЯ АНЕСТЕЗИОЛОГИЧЕСКОЙ ТАКТИКИ В ХИРУРГИЧЕСКОМ ЛЕЧЕНИИ ПЕРВИЧНО-МНОЖЕСТВЕННОГО НЕМЕЛКОКЛЕТОЧНОГО РАКА ЛЁГКОГО

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РЕЗЮМЕ

Описан клинический случай хирургического лечения пациента с первично-множественным злокачественным поражением легких (рак левого лёгкого, центральная перибронхиально-узловая форма с поражением верхнего долевого и дистальных отделов главного бронха, рак правого лёгкого центральная форма с поражением верхнего долевого бронха). Проведение радикального лечения состоялось благодаря использованию потенциала искусственного газообмена обоих лёгких двумя аппаратами с принципиально различной механикой вентиляции. Выбор необходимой тактики функциональной коррекции предполагаемой гипоксемии методом объемной и высокочастотной легочной вентиляции позволил избежать нарушения вентиляционно-перфузионного соотношения и предотвратить развития жизнеугрожающих осложнений, полноценно обеспечил адекватный газообмен данного пациента на этапах хирургического лечения.

Ключевые слова:
первично-множественный рак, рак лёгкого, хирургическое лечение, лобэктомия, искусственная вентиляция лёгких, газообмен.

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RELEVANCE

According to the International Agency for Research on Cancer and the World Health Organization, over the past decade, the number of new cases of cancer in the world has increased up to 14.1 million, and the number of deaths has reached 8.2 million people. The undisputed leader among oncological diseases is lung cancer (LC) – 13 % of cases among all malignant neoplasms in the world [1]. In Russia, according to statistical data, RL ranks first in morbidity and mortality among the male and female population with an annual detection of new cases of about 60,000 people [2]. Bilateral lung damage is detected in 0.08-3.5 % of cases [3]. In 80-85 % of cases, the morphological structure of RL is represented by non-small cell lung cancer (NSCLC): adenocarcinoma, large cell and squamous cell carcinoma. Surgical treatment of NSCLC is basic and involves removal of the organ (pneumonectomy) or anatomical resection of the lung with extended regional lymph node dissection [4, 5].

The improvement of oncosurgical techniques and anesthesiological support determines the feasibility of revising the criteria for functional and surgical operability of patients with common tumor processes [6] and contributes to improving the immediate and long-term results of radical surgical treatment of cancer patients [7, 8]. A specific feature of anesthesia in chest surgery is to ensure optimal and safe operations with the most adequate compensation for functional gas exchange. Standard methods of anesthesia and ventilation in this case may be ineffective. To ensure surgical operation, it is necessary to minimize the volume of the lung and partially or completely "turn it off" from the act of breathing [9]. However, the lack of gas exchange in the lung is extremely unphysiological. Given that the lungs are a bioactive organ, any deformity and / or temporary absence of respiration in one lung during surgery can trigger a cascade of pathological changes in homeostasis. Single-lung ventilation contributes to an increase in operational stress, causing the release of pro-inflammatory cytokines, and a violation of gas supply in the form of a decrease in the partial pressure of oxygen in the blood and cardiac output leads to the development of tissue hypoxemia [10, 11]. These systemic processes are accompanied by a change in the nature of the course of oxidative reactions, a violation of the energy supply of functions and plastic processes in tissues and organs. Destruction of non-cellular structures, cell death and systemic functional destabilization lead to disruption of the vital activity of the body as a whole [12, 13].

The expansion of indications for surgical treatment of a locally advanced lung tumor process encourages the search and development of new methods of anesthesiological aids, the main principles of which are effective protection against surgical aggression, full-fledged pulmonary ventilation with adequate gas exchange, correction of acid-base and water-electrolyte balances.

The purpose of the study: to demonstrate with this clinical example the possibility of performing surgical treatment of patients diagnosed with primary multiple lung cancer using two fundamentally different technologies of artificial ventilation.

Clinical case

Patient K., 60 years old, went to a doctor in August 2018, complaining of a cough with sputum of a mucopurulent nature, shortness of breath during physical exertion, intermittent pain behind the sternum, weakness and dizziness. He considers himself ill since May 2018, when there were clinical manifestations of the disease. Radiological examination at the place of residence revealed neoplasms in both lungs. The patient was referred to FSBI "Rostov Research Cancer Institute" RFHM for further examination and specialized care. According to the results of the examination, the diagnosis was made – primary multiple cancer: Cancer of the left lung, central peribronchial-nodular form with damage to the upper lobar and distal parts of the main bronchus, cT2NxM0, stage IIA. Right lung cancer is a central form with a lesion of the upper lobar bronchus, cT-1NxM0, stage I, clinical group 2.

Morphological examination: biopsy of a tumor from the anterior segmental bronchus (B3) on the right-foci of squamous cell carcinoma. Histological analysis: 1) from B3 on the right, No. 40978-82 / 18-foci of squamous cell carcinoma; 2) from the up-

per lobar bronchus on the left, No. 40983-88 / 18-foci of squamous cell carcinoma.

Concomitant diseases: chronic obstructive pulmonary disease of the first degree, stage 1, phase of remission; ischemic heart disease: atherosclerotic cardiosclerosis, circulatory insufficiency of the 1st degree; varicose veins of the lower extremities, chronic venous insufficiency of the 2nd degree. From 18.05.2018 to 26.07.2018, as part of the complex treatment, the patient underwent 3 courses of induction polychemotherapy according to the scheme cisplatin 360 mg + gemcitabine 6.0 g + refnot 900.000 IU. In the Department of Thoracic Surgery of the Federal State Budgetary Institution "RNIOI" of the Ministry of Health of the Russian Federation (03.08.2018), an operation was performed in the volume of expanded upper bronchoplastic lobectomy on the left. According to the histological analysis of 03.08.2018: highly differentiated squamous cell carcinoma with keratinization and foci of necrosis. The surgical intervention and the postoperative period were carried out without any special features or complications. The patient was discharged on the 25th day.

Upon re-hospitalization, standard physical, instrumental (external respiration function, computed tomography of the chest, fibrobronchoscopy, esophagoduodenoscopy, electrocardiography, ultrasound examination of the abdominal cavity, ultrasound Dopplerography of the vessels of the neck and lower extremities) and laboratory methods were performed to continue treatment on 26.09.2018.

Instrumental research data from 26.09.2018:

Electrocardiography: irregular rhythm 72 %, atrial fibrillation normal-systolic form, heart rate (HR) 80-85 per minute, slowing of atrial conduction of the myocardium, hypoxia and reduced recovery processes of the myocardium of the anterior-septum region of the left ventricle;

Evaluation of the function of external respiration: vital capacity of the lungs 46.73 %, forced vital capacity of the lungs 43.86 %, volume of forced air when exhaling in 1 second 47.52 %, a pronounced decrease in all indicators;

Fibrobronchoscopy: condition after bronchoplastic upper lobectomy on the left, bronchial anastomosis is stable, without signs of inflammation, peribronchial nodular cancer of the upper lobe of the right lung, deforming the lumen of the bronchus;

Laboratory parameters from 26.09.2018:

1) CBC: Hb 133 g/l, red blood cells $4.4*10^{12}$/l, color index 0.90, Ht 40 %;

2) Indicators of biochemical blood tests: amylase 40.4 U/l, ASTL 18.4 U/l, ALTL 17.3 U/l, creatinine 82.3 mmol/l, urea 6.59 mmol/L, total protein 79.6 g/l, bilirubin 6.5 mmol/l;

3) Acid-base state: PCO_2 40 mmHg, PO_2 81 mmHg, pH 7.401, BE 2.3 mmol/L, HCO3 23.3 mmol/L, SO_2 98 %, Na^+ 137.0 mmol/L, K^+ 4.8 mmol/L, Cl^- 101.0 mmol/L, Ca^{2+} ion – 1.12 mmol/l.

Taking into account the anamnesis of the disease (complex treatment, condition after 3 courses of induction polychemotherapy and extended upper bronchoplastic lobectomy on the left), concomitant pathology, data from instrumental and laboratory research methods, the doctors ' council of 27.09.2018 decided to perform surgery in the volume of bronchoplastic upper lobectomy on the right. The choice of the concept of functional correction of hypoxemia in this patient was based on the rational use of the potential of artificial ventilation of both lungs in gas exchange. This scheme was provided by the use of separate intubation and ventilation of both lungs with two ventilators (artificial lung ventilation) different in mechanics: volumetric and high-frequency. Ventilation of the left lung (the remaining segments) was performed with the device No. 1 Drager Infinity C 700 in the volume control mode (CMV), the right – high-frequency (HF) (device No. 2 ZisLine JV 100B) in the catheter ventilation mode. In this case, it was impossible to use volumetric ventilation of both lungs as a result of the anatomical location and features of the tumor growth (Fig. 1).

The method of HF ALV (high-frequency artificial lung ventilation) is considered to be lung ventilation performed at a frequency of more than 60 cycles per minute. This mode with a respiratory rate of 100 or more oscillations per minute is achieved by reducing the respiratory volume to 100-150 cm^3 (1.5-2.5 cm^3 / kg) and shortening the inhalation phase to 0.1-0.01 s. This technique is accompanied by a slight increase in intra-pulmonary pressure with an improvement in hemodynamic parameters

compared to traditional methods of ventilation. The most common option is a jet HF ALV ventilator with a respiratory rate of 100-300 per minute through an adapted catheter.

Surgical intervention in this patient required compliance with all the basic and generally accepted principles of multicomponent balanced anesthesia, with the exception of ventilation. Intraoperative monitoring met the Harvard standard and included cardiomonitoring, monitoring of blood gas composition, assessment and analysis of the bispectral index, and monitoring of neuromuscular conduction.

On the day of the operation (29.09.2018), after standard premedication, patient K. was taken to the operating room at 9:00. Baseline functional parameters: blood pressure (BP) 150/100 mmHg, heart rate 84 per minute, respiratory rate 17 per minute, SpO_2 (blood saturation) 94 %. Under ultrasound navigation, the cubital and right subclavian veins were punctured and catheterized according to the Seldinger method. For the purpose of prolonged anesthesia in the Th3-Th4 interval, the epidural space was punctured and catheterized. After the test dose, a continuous infusion of ropivacaine hydrochloride was initiated at a rate of 5-6 ml/hour [14, 15]. At 9:30, after standard induction with propofol at a dose of 2-3 mg/kg, fentanyl 2 mcg/kg, and rocuronium bromide 1 mg/kg, the trachea was intubated with a thermoplastic two-light tube No. 39 Left. The correct position of the endotracheal tube was confirmed by bronchoscopy.

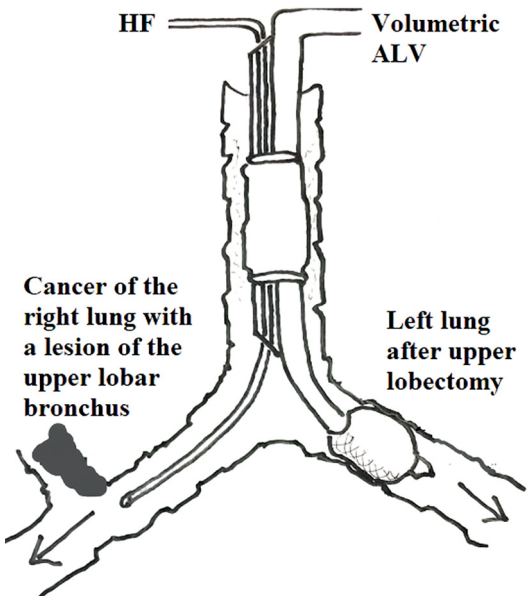

Fig. 1. Separate ventilation of the lungs: the right – high-frequency (HF), the left lung (the remaining segments) in the volume-controlled mode.

Artificial ventilation of the early operated left lung, i.e. the remaining lower lobe after extended upper bronchoplastic lobectomy, was performed with the Drager Infinity C 700 device No. 1 – in the volume control mode (CMV): respiratory volume (RV) 200 ml, minute respiratory volume (MRV) 3.7 l/min, BH 18 per minute, Ppeak (peak airway pressure) +28 cm of water, PEEP (positive end respiratory pressure/ constant positive airway pressure). 0 cm of water, FiO2 (fractional oxygen content in the inhaled air) 80 %. The breathing circuit is partially reversible, sealed.

The right lung, whose tumor was planned to be removed, was ventilated with apparatus No. 2 (high-frequency jet ZisLine JV 100B) in the jet ventilation mode with a catheter inserted into the right main bronchus. ALV parameters: BH 80 per minute, MRV 10 l/min, resulting in a respiratory volume (RV) 140 ml. The ventilation modes of the high-frequency device were changed during the operation. During the revision and rotation of the right lung, the respiratory rate was increased to 120 per minute, with a MRV of 10 l/min, RV 60-80 ml. At the same time, the gas exchange area in the operated lung did not decrease. These regimens did not prevent radical removal of the tumor. The course of anesthesia proceeded without cardio-respiratory disorders. Restrictive infusion therapy according to the standard scheme for such surgical interventions was carried out by dosed administration of a balanced crystalloid solution at a rate of 3-5 ml/kg*h. The average blood pressure was kept at the level of 62-74 mmHg.

At 12:20 after the end of the main stage of the operation, adequate hemostasis and pneumostasis, the patient was transferred to double-lung ventilation in the CMV mode: UP to 450 ml, BH 15 per minute, MRV 6.2 l/min, FiO_2 60 %. Against this background, SpO_2 is 97 %. In the control study of the gas state of arterial blood, decompensation of indicators was not observed: pCO_2 42.3 mmHg, pO_2 140 mmHg,

pH 7.370, BE 7.4 mmol/L, HCO_3 31.2 mmol/dL, SO_2 94 %, Na^+ 141.0 mmol/dL, K^+ 3.8 mmol/dL, Cl^- 103.0 mmol/dL, Ca^{2+} ion –1.26 mmol/l. Vital functions were monitored. Hemodynamic parameters remained stable: blood pressure 127/85 mmHg, heart rate 86 per minute, pulse 81 per minute (pulse deficit 5 beats per minute).

At 13:45, the operation is completed. The duration of the operation was 3 hours and 45 minutes. An extended bronchoplastic upper lobectomy was performed on the right. At 14:10, after full recovery of consciousness and muscle tone, rehabilitation of the tracheobronchial tree, oral cavity, the patient was extubated. The duration of anesthesia was 4 hours and 40 minutes. No episodes of hypoxemia were recorded. After extubation, the patient's oxygen therapy was continued using a high-flow air-oxygen mixture flow generator with parameters: flow 20 l/min, temperature 37 °C, FiO_2 40-50 %. Against this background, the patient's functional indicators were as follows: Blood pressure 126/76 mmHg, heart rate 78 per minute, BH 16 per minute, SpO_2 97-99 %. Respiratory deficiency was absent, which was confirmed by laboratory data on the gas composition of arterial blood: pCO_2 35 mmHg, pO_2 139 mmHg, pH 7.412, BE – 0.5, HCO_3 25.3 mmol/dL, SO_2 97 %, Na^+ 142.0 mmol/dL, K^+ 4.1 mmol/dL, Cl^- 103.0 mmol/L, Ca^{2+} 1.04 mmol/dL.

In the early postoperative period, the patient received standard drug therapy, which included infusion, antibiotic therapy, prevention of thrombogenic complications, oxygen therapy, inhalation with mucolytics and bronchodilators. Postoperative analgesia was performed by titrated background epidural analgesia (Noel-Brevik type mixture) with periodic anesthetic boluses as indicated. The adequacy of postoperative analgesia was determined using the visual-analog pain scale (VAS). The average indicator of the intensity of the pain syndrome during the first day was 2.6 points, which did not require additional administration of opioids. In the Department of Anesthesiology and resuscitation, patient K. was under observation for 2 days, after which, in a satisfactory condition, he was transferred to the specialized department under the supervision of the attending physician to continue treatment.

DISCUSSION

Among the methods of respiratory support that provide the necessary oxygenation of patients during anesthesia, the traditional use of volumetric ALV (CMV ventilation mode – volume control) occupies a leading position. The choice of HF ALV takes place in the surgical treatment of pathology of the thoracic cavity. Optimization of ventilation support of HF ALV during operations on the trachea and bronchi, helps to maintain the necessary oxygenation in the absence of airway tightness. The combination of volumetric ALV of the independent lung and HF ALV of the contralateral lung is one of the ways to ensure proper gas exchange in thoracic surgery for pulmonary bleeding, gangrene or lung abscess, bronchopleural fistulas [9]. Among the scientific publications there is evidence of the use of independent separate ventilation as a method of treatment of postoperative complications of lung transplantation and in unilateral diseases of the lung parenchyma. At the same time, in the available scientific literature, we have not seen such clinical observations in the surgical treatment of lung tumor lesions.

It should be noted that the main task facing the anesthesiologist in this clinical case was to prevent the development of hypoxemia and hypercapnia during ventilation of the previously operated lung (bronchoplastic upper lobectomy on the left) due to a decrease in the gas exchange area. This was provided by separate intubation and ventilation with two breathing apparatus with different operating principles (volumetric and high-frequency), which allowed minimizing airway injury and optimizing the patient's oxygen supply. The use of a tactical approach in surgical treatment using two fundamentally different technologies of lung ventilation in a patient with primary multiple lung cancer had no complications. However, it is necessary to take into account the potential risk of HF ALV in the form of an aspiration component by blood and tumor masses, as well as the occurrence of barotrauma in the absence of a sufficiently effective exhalation.

When using high-frequency ALV, the currently operated lung was not collapsed, and, as a result,

there were no newly formed areas of atelectasis. The creation of positive pressure in the airways led to a decrease in the dead space in the lungs and an increase in their gas exchange area, which contributed to adequate oxygenation and mucociliary clearance. The use of this technique made it possible to reduce violations of the ventilation-perfusion ratio, thereby avoiding the development of life-threatening complications.

CONCLUSIONS

Based on the analysis of clinical and laboratory data, it can be stated that the method of using two fundamentally different lung ventilation technologies is applicable in patients with primary multiple lung cancer. The choice of this anesthetic support provided an opportunity to perform radical surgical treatment in a patient with subcompensated contralateral lung function.

Authors contribution:
Tikhonova S.N. – conducting anesthesia, analysis of the data obtained, writing the text of the manuscript.
Rozenko D.A. – determination of research objectives, study design.
Ushakova N.D. – analysis of the data obtained, consultation.
Popova N.N. – direct conduction of the study.
Skopintsev A.M. – carrying out laboratory research, obtaining data for analysis.
Shulga A.V. – processing and analysis of results.
Ten I.A. – participation in the study.

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