

IMPROVING THE METHOD OF HEMO- AND AEROSTASIS IN LUNG SURGERY USING THE DOMESTIC HEMOSTATIC WOUND COATING "HEMOBEN"

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Abstract.

For clinical surgery, a method of preventing the development of disorders of aero- and hemostasis has been improved, which provides for a two-component strengthening of the zone of resected lung tissue by local application of a hemostatic agent with the formation of a sealed film with subsequent fixation of the parietal pleural leaf to it. Studies have shown that polymerization of the "Nemoben" powder on the wound surface of the lung occurs in a short time, is characterized by sufficiently strong adhesion and aerostasis, and fixation of the free pleural flap provides elasticity of the coating, as well as a long-term effect with prevention of the development of the adhesive process.

Keywords: hemo- and aerostasis; Hemoben; bullous disease; fixation of a free pleural flap.

The relevance of the problem. Air discharge after lung resection ranges from 25% to 50% on the 1st day after surgery and up to 20% on the 2nd day [1, 2]. This complication, which persists for more than 5 days after surgery, is determined by the Society of Thoracic Surgeons (STS Society of Thoracic Surgeons) as a postoperative complication called prolonged air leakage.

Prolonged air leakage - the communication of the alveoli of the pulmonary parenchyma distal to the segmental bronchus with the pleural cavity always indicates the failure of aerostasis [3]. Performing a lobectomy increases the risk of air leakage by 1.5–2.0 times compared to atypical sublobar resections due to the need to dissect the interlobular furrows, especially in conditions of their mild severity [4, 5]. Despite the fact that most air discharges resolve spontaneously, the frequency of prolonged air discharge after lung resection has not decreased in recent decades, ranging from 10% to 15% [6, 7].

Prolonged air leakage negatively affects the course of the postoperative period. The frequency of empyema development reaches 10.4% with air discharge for more than 7 days, compared with 1% with air leaks within 7 days [8]. Prolonged air leakage requires prolonged drainage of the pleural cavity, which increases and prolongs postoperative pain [9, 10]. In turn, difficult coughing leads to the development of postoperative pneumonia [11], and a decrease in the patient's mobility is accompanied by a high risk of thromboembolic complications [12, 13]. Prolonged air leakage is associated with an increase in hospital mortality [14, 15]. Patients with prolonged air leakage have a 3.4 times greater risk of dying than patients without this complication [16, 17].

Taking into account these factors, together with the staff of the State Institution "Republican Specialized Scientific and Practical Medical Center of Surgery named after Academician V. Vakhidov" for the period from April to August 2022, three series of experimental studies were initially conducted: *in vitro*, to assess the degree of adhesion of coatings in a humid environment; *ex vivo*, to study the effectiveness of wound coatings to achieve aerostasis on isolated sheep lungs; *in vivo*, to study the reaction of biological tissues and wound healing of the lung in an experiment on laboratory rats. 3 types of coatings were used: Biological glue (based on cyanoacrylate) in liquid form, using a syringe. Collagen sponge (LLC "Turon Silk Pharm") size 4x4 cm Hemostatic implant "Hemoben" in the form of a powder of cellulose derivatives. Based on the results of experimental morphological studies, the next task was to develop a method for improving aero- and hemostasis for clinical lung surgery.

Materials and methods of research. A clinical group was formed to investigate and evaluate the effectiveness of the proposed method of preventing the development of disorders of aero- and hemostasis after resection operations on the lungs. This study is primary in terms of evaluating the effectiveness of domestic Hemoben. After the resection stage of lung surgery, in order to achieve stable aero- and hemostasis in 58 patients (2022-2023), the proposed method was applied using the domestic hemostatic agent Hemoben. Among the etiological diseases that caused the marginal resection of the lung in most cases in both groups was echinococcosis – 38 (59.4%) cases in the comparison group and 34 (58.6%) in the main group. Boulez disease was noted in 16 (25%) and 15 (25.9%) cases, respectively, bronchiectatic disease – 5 (7.8% and 5 (8.6%), as well as lung abscess – 5 (7.8% and 4 (6.9%) patients. All patients were operated on as planned.

Results and discussion. The article is devoted to the presentation of the technical aspects of the new method. Federation of Russia Patent No. 2376948 C1, a method of aero- and hemostasis during resection operations on the lungs, was accepted as the closest analogue. The essence of the method consists in resection of the lung and application of synthetic material from oxidized regenerated SURGICEL cellulose to its surface. At the same time, 1.5-2 minutes after SURGICAL fixation, HemoCompact glue is applied from the syringe to its entire surface with an even layer.

However, firstly, SURGICAL is a fairly expensive drug, in addition, it is not able to provide reliable and stable aerostasis and hemostasis. And the biological glue HemoCompact does not have the ability to biodegrade and therefore the adhesive coating is rejected with subsequent complications. Also, the glue tightens the surface of the lung and deforms it, which reduces the excursion of the lungs.

The objective of the invention is to develop a method for reliable aero- and hemostasis after resection operations on the lungs, while inexpensive and easy to perform.

The task is solved by the fact that the method of hemo- and aerostasis in lung surgery includes resection of the lung, application of a cellulose-based drug to its surface, drainage and suturing of the wound, as a cellulose-based drug, a powdered composition "HEMOBEN" (containing Na-carboxymethylcellulose, oxidized viscose) is applied to the wound surface of the lung by insufflation, oxidized cellulose, calcium chloride in the ratio, wt. % respectively: 46,5%, 10,5%, 19,0%, 24,0%) with a particle size of no more than 100 microns, at the rate of 200 micrograms of powder per 10 cm² of the wound surface of the lung, then after 2-3 minutes, the excess of the powdered composition is removed by washing with an antiseptic jet for 5 seconds, after which the specified powdered composition Hemoben is re-applied

from calculation of 100 micrograms of powder per 10 cm² of lung parenchyma with the expansion of the powder spraying zone in all directions by 1.5-2.0 cm from the edge of the primary treated surface, then a free flap of the parietal pleura is applied to the treated surface and tightly pressed for 2 minutes and the operation is completed in the usual manner.

To implement the described method, a domestic bioabsorbable surgical hemostatic agent was used from a composite polymer material from cotton cellulose derivatives "HEMOBEN", developed at the State Institution "Republican Specialized Scientific and Practical Medical Center of Surgery named after Academician V. Vakhidov", for which the patent "Bioabsorbable surgical hemostatic agent" of the Intellectual Property Agency of the Republic of Uzbekistan was obtained (IAP 05906 dated 04/24/2015). Local production and low price of the drug ensures its availability for medical and preventive institutions and for a wide segment of the population.

Hemostatic agent "HEMOBEN" has the ability to quickly stop bleeding [18, 19], high biocompatibility, easily decomposes and has a positive effect on wound healing, accelerating the healing process and restoration of the mucosa, improves the regenerative and drainage functions of the tracheobronchial tree.

The domestic bioabsorbable agent "HEMOBEN" is a composition containing Na-carboxymethyl cellulose, oxidized viscose, oxidized cellulose, calcium chloride in the ratio, by weight. % respectively: 46,5%, 10,5%, 19,0%, 24,0%.

At the same time, Na-carboxymethylcellulose is a hydrophilic component, has increased adhesion to tissues. It dissolves quickly in water and physiological fluids. Bio-dissolution within 1 day.

Oxidized cellulose is a hydrophilic component of the drug. It has a hemostatic property. In aqueous solutions, it takes a dispersed form. Biodegradation in 2-3 weeks.

Ca⁺ - ions are the most powerful factor of hemostasis, provide rapid hemostasis by forming a blood clot.

Viscose is an artificial polymer of cellulose. It has the property of biodegradation in a longer period than carboxymethylcellulose (up to 3-4 weeks). Biocompatible. It has a hemostatic effect. Provides a prolonged effect of the coating.

In our method, HEMOBEN is used not only for its main purpose – a hemostatic agent, but also as a means effective for aerostasis after resection operations on the lungs.

The method is performed as follows.

After performing the stages of lung resection with suturing of the bronchial lumen, an aerostasis check is performed, if there is an air supply from the lung parenchyma, then fine HEMOBEN powder is applied to the wound surface of the lung using insufflation (particle size no more than 100 microns) at the rate of 200 micrograms of HEMOBEN per 10 cm² of the lung parenchyma. Further, 2-3 minutes after the formation of the film, the excess powder is removed by washing with an antiseptic jet for 5 seconds, after which HEMOBEN powder is reapplied at the rate of 100 micrograms of powder per 10 cm² of lung parenchyma with the expansion of the powder spraying zone in all directions by 1.5-2.0 cm from the edge of the initially formed film. Then a free flap of the parietal pleura is applied to this area, the latter is pressed tightly for 2 minutes, which contributes to the tight fixation of the pleura to the wound surface (Fig. 1-5). The surgical wound is sutured with the drainage tube left.

Advantages:

- the method is inexpensive, quite simple in execution;

- wound coating in the form of a powdered HEMOBEN composition is a biocompatible hemostatic and aerostatic with a biodegradation period of 2-3 days;
- the formation of a composite polymerizing wound coating in contact with blood with the adhesion of a free flap of the parietal pleura to it with blood promotes prolonged biodegradation of the coating, which increases the duration of aerostasis;
- the formed coating is elastic, which does not reduce the excursion of the lungs and does not lead to their deformation.

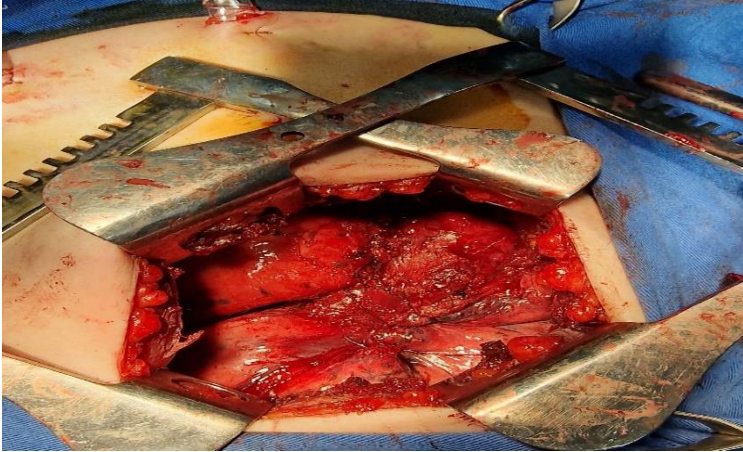


Fig. 1. Patient. I., 36 years old. Intraoperative type of echinococcosis of the lung

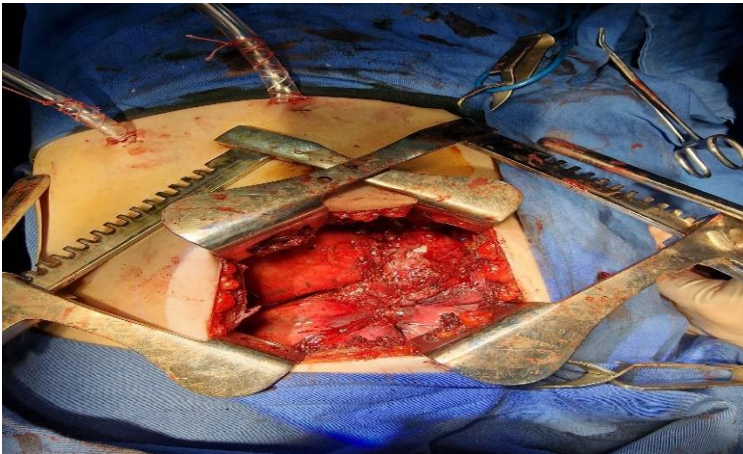


Fig. 2. View after lung resection



Fig. 3. View after applying Hemoben powder to the resection surface of the lung



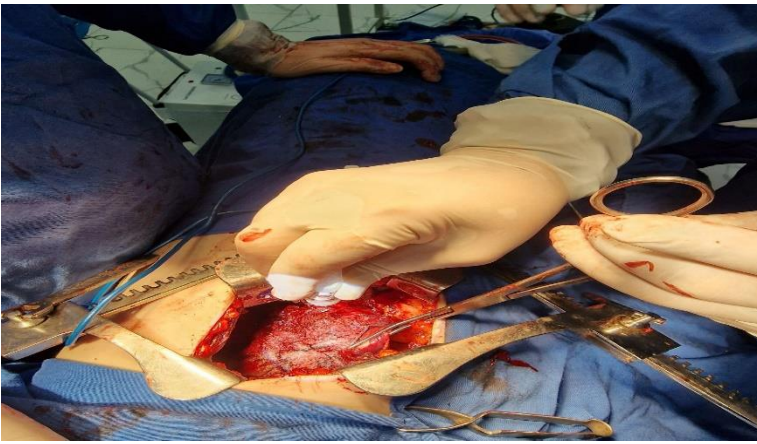


Fig. 4. Formed film after polymerization of Hemobene powder

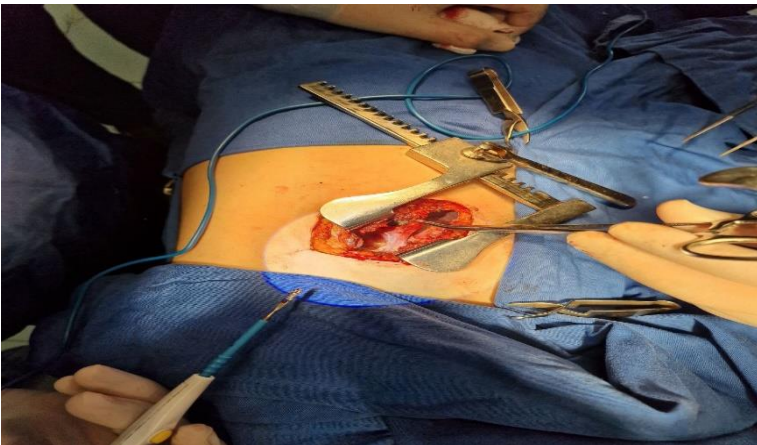


Fig. 5. Fixation of a fragment of the parietal pleura on top of the formed film of Hemobene powder

The method is confirmed by examples of a specific execution.

Clinical example No. 1

Case history No. 273

Abdullaev Bahodir Kuranboevich, born in 1966, (57 years old).

Date of receipt: 06.02.2023

Date of discharge: 09.02.2023

Diagnosis: Volumetric formation of the left lung in/lobe.

Entered as planned.

Complaints upon admission: pain in the left half of the chest, an increase in body temperature to high numbers, cough, dry cough, sometimes sputum, general weakness.

Anamnesis of the disease: According to the words, he has been ill for a month. He does not associate his disease with anything. Regarding the pain in the left half of the chest, he sought medical help where a CT scan of the chest was performed and a volumetric formation of the upper lobe of the left lung was revealed (06.02.2023): The patient was examined by a surgeon, hospitalized in the surgery department for surgical treatment.

The general condition of the patient upon admission of moderate severity, clear consciousness, active position, correct physique, normal nutrition. The skin and visible mucous membranes of the usual color. Peripheral lymph nodes are not enlarged, the musculoskeletal system is without deformities. The chest is cylindrical in shape. There are no palpationally painful points. Percussive pulmonary sound on the right, dullness on the upper left. Auscultation on the right is vesicular breathing, there are no wheezes, on the left the



upper part is sharply weakened. The frequency of respiratory movement is 19 in 1 min. at rest. Heart - clear, rhythmic tones, blood pressure 120/80 mmHg. Pulse-86 beats in 1 min. The tongue is clean, moist, the abdomen is palpationally soft, painless, the liver is at the edge of the costal arch, the spleen is not palpable. The stool is regular, the diuresis is not disturbed.

The patient was examined: Hemoglobin-121g/l; Erythrocyte-3.6; leukocyte-9.2; bilirubin total-28; direct-0; Aspartate aminotransferase-29; Alanine aminotransferase-21; blood glucose-5.1 mmol/l; total protein-63 g/l; urea-4.3 mmol/l; creatinine-91.0. ECG - sinus rhythm, heart rate - 86 per minute. CT of the chest organs: In the projection of the left lung segment 3, the volumetric formation of the left lung, paracystic infiltration of the left lung is determined. The roots of the lungs are heavily compacted. The domes of the diaphragm and the sinuses on the left are not differentiated.

Ultrasound examination of the abdominal organs 04.02.2023g: The liver is not enlarged. Inter-field boundary: not expressed. Right lobe of the liver: 14.0 cm, Left lobe of the liver: 6.9 cm. Parenchymal structure: diffuse- heterogeneous. Parenchyma: increased echogenicity. Hepatic veins: not dilated. Intrahepatic ducts: not dilated. Choledoch: 0.5 cm. Gallbladder: 6.6 x 2.5 cm. The walls are not thickened. The cavity is transparent.

Date of operation: 06.02.2023 years.

Name of the operation: Lateral thoracotomy on the left, marginal resection of the upper lobe of the left lung. Drainage of the left pleural cavity.

Operation protocol. Under endotracheal anesthesia, after appropriate treatment of the surgical field with 3-fold betadine, a lateral thoracotomy was performed on the left intercostal 5, the length of the skin incision up to 11 cm, then the left pleural cavity was opened. During the revision of the pleural cavity, the lung is pink, elastic, there is no effusion. At the level of the 3 segment of the upper lobe, a rounded formation with a size of 3.5 x 3.5 cm is palpated, which occupies the entire upper marginal lobe, it was decided to perform resection of this part. The Organ suture US-60 apparatus is applied to this area at the level of healthy tissue with the capture of education. The suture line is reinforced with atraumatic thread prolene 3-0. Further, fine Hemoben powder was applied to the wound surface of the lung (particle sizes no more than 100 microns) at the rate of 200 micrograms of powder per 10 cm² of lung parenchyma, about 15 cm² was covered in total, then 3 minutes after the formation of the film on the wound surface, the excess powder was removed by washing 50 ml of 0.9% NaCl solution from a syringe in within 5 seconds, after which Hemoben powder was re-applied at the rate of 100 micrograms of powder per 10 cm² (total 200 mg) with the expansion of the powder application zone from the vial in all directions by 1.5 cm from the edge of the initially formed film. Next, a free flap of the parietal pleura was applied to this area, which was tightly pressed for 2 minutes – until a tight fixation of the pleura to the wound surface was achieved. Further, the pleural cavity was sanitized. The water sample is hermetically sealed. Hemostasis, aerostasis, two lower drains, rib tightening, layer-by-layer suturing after an operating wound, aseptic dressing.

Conclusion. For clinical surgery, a method for preventing the development of disorders of aero- and hemostasis has been improved, which provides for a two-component strengthening of the zone of resected lung tissue by local application of a hemostatic agent with the formation of a sealed film with subsequent fixation of the parietal pleural leaf to it. Studies have shown that the polymerization of Hemoben powder on the wound surface of the lung occurs in a short time, is characterized by sufficiently strong adhesion and aerostasis,

and the fixation of the free pleural flap ensures the elasticity of the coating, as well as a long-term effect with the prevention of the development of the adhesive process.

References:

- 1.Cerfolio RJ, Bass C, Katholi CR. Prospective randomized trial compares suction versus water seal for air leaks. *Ann Thorac Surg* 2001;71(5):1613-7.
- 2.Gilbert S, McGuire AL, Maghera S, et al. Randomized trial of digital versus analog pleural drainage in patients with or without a pulmonary air leak after lung resection. *J Thorac Cardiovasc Surg* 2015; 150(5):1243-51.
- 3.Cerfolio RJ. Advances in thoracostomy tube management. *Surg Clin North Am* 2002;82(4).
- 4.Varela G., Jimenez M.F., Novoa N., Aranda J.L. Estimating hospital costs attributable to prolonged air leak in pulmonary lobectomy // *Eur J Cardiothorac Surg.* - 2005. - Vol. 27. - P. 329-33.
- 5.Yoo A, Ghosh SK, Danker W, et al. Burden of air leak complications in thoracic surgery estimated using a national hospital billing database. *Clinicoecon Outcomes Res* 2017;9:373-83.
- 6.Cerfolio RJ, Pickens A, Bass C, et al. Fast-tracking pulmonary resections. *J Thorac Cardiovasc Surg* 2001;122(2):318-24.
- 7.Abolhoda A, Liu D, Brooks A, et al. Prolonged air leak following radical upper lobectomy: An analysis of incidence and possible risk factors. *Chest* 1998; 113(6):1507-10).
- 8.Brunelli A, Xiume F, Al Refai M, et al. Air leaks after lobectomy increase the risk of empyema but not of cardiopulmonary complications: A case-matched analysis. *Chest*, 2006 Oct;130(4):1150-6.).
- 9.Mueller MR, Marzluf BA. The anticipation and management of air leaks and residual spaces post lung resection. *J Thorac Dis* 2014;6(3):271-84.
- 10.Sapaev DS, Yakubov FR, Yakhshiboev SS. Evaluation of the factors influencing the choice of laparoscopic echinococcectomy in liver echinococcosis (LE) and its impact on postoperative outcomes. *Exp Parasitol.* 2023 May;248:108495. doi:10.1016/j.exppara.2023.108495. Epub 2023 Mar 5. PMID: 36871791
- 11.DeCamp MM, Blackstone EH, Naunheim KS, et al. Patient and surgical factors influencing air leak after lung volume reduction surgery: lessons learned from the national emphysema treatment trial. *Ann Thorac Surg* 2006;82(1):197-206.
- 12.Sanchez PG, Vendrame GS, Madke GR, et al. Lobectomy for treating bronchial carcinoma: Analysis of comorbidities and their impact on postoperative morbidity and mortality. *J Bras Pneumol* 2006 Nov-Dec;32(6):495-504.
- 13.Yakubov FR, Sapaev DS. Surgical treatment of liver echinococcosis. *J Med Life.* 2022 Nov;15(11):1409-1414. doi:10.25122/jml-2022-0268. PMID: 36567844; PMCID: PMC9762364.
- 14.Elsayed H, McShane J, Shackcloth M. Air leaks following pulmonary resection for lung cancer: Is it a patient or surgeon related problem? *Ann R Coll Surg Engl.* 2012 Sep;94(6):422-7.
- 15.Yakubov Farkhod Radjabovicha, Sapaev Duschan Shukhratovich, & Niyazmetov Sevarbek Bakhtiyorovich. (2023). The treatment of the results of pleural empyema complicated with

- bronchopleural fistula. Research Journal of Trauma and Disability Studies, 2(4), 241–246. Retrieved from <http://journals.academiczone.net/index.php/rjtds/article/view/748>
16. Yoo A, Ghosh SK, Danker W, et al. Burden of air leak complications in thoracic surgery estimated using a national hospital billing database. Clinicoecon Outcomes Res 2017;9:373–83.
17. Якубов Ф.Р, Сапаев Д.Ш, & Ниязметов С.Н. (2023). Ўпканинг анатомик резекциясидан кейинги асоратлар. Journal of Universal Science Research, 1(5), 10–12. Retrieved from <https://universalpublishings.com/index.php/jusr/article/view/602>
18. Yakubov F.R., Sadykov R.A., Mardonov J.N., Erniyazov E.A., Sapaev D.S. Evaluation of Hemostatic Efficacy of HemobenGel in Ruptures Of The Gastric Mucosa in An Experiment. Bull. Env. Pharmacol. Life Sci., Vol 12 [8] July 2023: 56-66.
19. Якубов Ф.Р., Сапаев Д.Ш., Эрниязов Э.А., Матқурбонов Н.О., Якубов Р.Ф. Меллори - Вейсс синдромини кам инвазив усуллари қўллаган ҳолда ташхислаш ва даволаш. Биология ва тиббиёт муаммолари. 2023, №1 (142). – Б. 143-145.

