© Aluna Publishing Wiadomości Lekarskie Medical Advances, VOLUME LXXVI, ISSUE 10, OCTOBER 2023

ORIGINAL ARTICLE

# TREATMENT EXPERIENCE OF CHRONIC LUNG ABSCESSES USING MINI-INVASIVE ELECTROSURGICAL TECHNIQUES

DOI: 10.36740/WLek202310122

### Аnton A. Serenko1, Vasyl H. Hroma1,2, Dmytro V. Minukhin1,2, Denis O. Yevtushenko1,2, Volodymyr V. Tkachenko1,3, Vasyl V. Kritsak1,3, Pavlo I. Korzh1,3

1. STATE INSTITUTION «INSTITUTE OF GENERAL AND EMERGENCY SURGERY V. T. ZAITSEV NATIONAL ACADEMY OF MEDICAL SCIENCES OF UKRAINE», KHARKIV, UKRAINE
2. KHARKIV NATIONAL MEDICAL UNIVERSITY, KHARKIV, UKRAINE
3. EDUCATIONAL AND SCIENTIFIC MEDICAL INSTITUTE OF THE NATIONAL TECHNICAL UNIVERSITY «KHARKIV POLYTECHNIC INSTITUTE», KHARKIV, UKRAINE

**ABSTRACT**

**The aim:** To increase the efficiency of surgical treatment of patients with chronic lung abscesses by developing mini-invasive methods of surgical treatment using electrosurgical technologies.

**Materials and methods:** Conducted study of the results of surgical treatment of 78 patients with chronic lung abscesses operated from 2011 to 2021. Patients were divided into two groups: the main group (37 patients who were treated using developed technologies) and a comparison group (41 patients, treated using traditional tactics).

**Results:** Transthoracic and endobronchial sanitation of the purulent cavity in the lung at the first stage of treatment contributed to the rapid elimination of inflammation and significantly accelerated the regeneration of lung tissue. Clinical effectiveness in the main group was expressed in reducing the phenomena of intoxication, decrease in Leukocyte intoxication index (LII) (early as on day 5 after surgery), on the 10th day, a significant reduction in patients bacterial excretion was noted (in the main group by 18.9%, in the comparison group – by 14.6%), the average time of reducing the abscess cavity by 1/4 of the volume 6 days less, the healing time of the cavity of the AL which is on average 13 and 16 days, respectively, less.

**Conclusions:** The developed methods of surgical interventions made it possible to significantly positively influence the level of endogenous intoxication indicators, avoid resection surgical interventions, reduce the number of postoperative complications, avoid damage to neighboring organs, reduce the time of patients with achieving a stable positive effect.

**K EY WORDS:** chronic lung abscess, argon-plasma coagulation, electrosurgery

## INTRODUCTION

Chronic lung abscesses (CAL) are still one of the most severe pathologies in thoracic surgery [1, 2]. Many researchers note that the number of patients with CAL are still remains at a fairly high level and amounts to 49.7% of the total number of purulent and destructive diseases of the chest cavity [3, 4]. It is known that this pathology is characterized by a severe long course, complexity and low effectiveness of known methods of treatment and consistently unfavorable treatment results [5, 6]. The severity of the condition of this contingent of patients, and the need for urgent medical measures create prerequisites for the constant improvement of methods of their diagnosis and treatment [7, 8].

Wiad Lek. 2023;76(10):2277-2282

One of the ways to improve the results of treatment of patients with CAL, according to leading experts, is to find new ways to treat this disease, in particular with the help of mini-invasive transthoracic and endobronchial surgical methods, methods of local treatment of the destruction cavity with chemical and physical factors and correction of the activity of the inflammatory process [9, 10].

## THE AIM

Is to improve the efficiency of surgical treatment of patients with chronic lung abscesses by developing mini-invasive methods of surgical treatment using electrosurgical technologies.

## MATERIALS AND METHODS

We conducted a randomized controlled single-center retro-prospective study, which is based on the analysis of the results of surgical treatment of 78 patients with chronic lung abscesses operated on the basis of SE «Institute of General and Emergency Surgery by V. T. Zaitsev NAMS of Ukraine», Kharkiv from 2011 to 2021.

According to the objectives of the study, patients were divided into two groups: the main group (37 patients who were treated from 2016 to 2021. using developed technologies) and a comparison group (41 patients) (patients treated from 2011–2015 using traditional tactics).

All studied patients underwent a general clinical examination in accordance with the approved medical care procedures and standards of medical care in Ukraine. The definition and conduct of additional methods for examining patients were determined by the features of the clinical course and nature of the disease, as well as the goals and objectives of this study.

Leukocyte intoxication index (LII) and lymphocyte index (LI) were separately evaluated.

To study the cellular composition, quantitative and qualitative composition of pathogenic microflora, as well as its sensitivity to antibacterial drugs, sputum was collected and the contents of purulent cavities, followed by seeding on nutrient media and bacterioscopy. To this end, the study was carried out at the time of admission of the patient, and then after puncture and drainage of the purulent cavity in the lung and on the 5-th, 10-th and 20-th day from the operation. The material for the study was sputum, abscess cavity contents and bronchial washings from patients with chronic lung abscesses.

In the treatment of patients of the main group, the method of argon-plasma coagulation (APC) was used, which is a contactless method of high-frequency electrosurgery. Its principle is the thermal effect of a high frequency current supplied to the tissue by a stream of ionized argon plasma.

We considered the following clinical situations as indications for the use of minimally invasive-draining methods of surgical treatment in 43.5% of patients in the study groups: 1. a blocked, peripherally located chronic lung abscess; 2. a peripherally located chronic abscess that is insufficiently drained through the bronchial tree; 3. peripherally located chronic lung abscesses, whose diameter exceeds 5 cm, regardless of the presence or absence of drainage through the bronchus. These interventions were performed according to preliminary data of polyposition X-ray examination or under the control of fluoroscopy and under the control of ultrasonography.

In the case when the manure drained through the bronchus, we actively used endoscopic methods to sanitize its cavity. In patients with sharp violations of the drainage function of the bronchi, rehabilitation began with urgent therapeutic bronchoscopy. After the evacuation of purulent contents and determination of draining bronchus by us, under X-ray control, catheterization of the orifice of draining bronchus or abscess cavity was carried out wa ith polychlorvinyl catheter, which was left for 7–10 days depending on the rate of elimination of purulent tracheobronchitis and cleaning of the cavity of СAL. If it was impossible to leave the catheter, therapeutic bronchoscopy was performed every other day, a total of 6–12 per course of treatment. Patients who were in serious condition and who could not carry out program bronchoscopies performed micro tracheostomy (MTS), which, in our opinion, was especially important in patients with severe respiratory failure, which occurs as a result of the active withdrawal of purulent sputum and concomitant purulent tracheobronchitis and does not allow for adequate bronchoscopic sanation and can lead to the development of asphyxia. Endobronchial methods of treatment included sanation bronchoscopy with pouring of medicinal mixtures, endoscopic catheterization of draining bronchi with subsequent sanation, and formation of micro tracheostomy with the performance of laryngeal fillings of satisfying solutions.

The reference point to the beginning of the second stage of treatment in patients of the study group was a dynamic bacteriological study. It should be noted that in all patients studied, the microbial number on day 1 of treatment was approximately the same and amounted to 1x108-9 CFU/ml. On the 5th day of treatment, the microbial number averaged 1x106 CFU/ml. On the 10th day, the microbial number in the vast majority of patients was below the critical level (1x103 CFU/ml).

In patients of the main group, at the second stage of treatment, the abscess capsule was treated with APK, which was used during endobronchial sanation using the working part of the coagulator conducted through the biopsy channel of the bronchoscope in 18 (48.6%) patients. In 17 (45.9%), this manipulation was performed transthoracically by conducting a bronchoscope with a coagulator through earlier drainage into the abscess cavity for visual control of its implementation. (the total number of procedures ranged from 8 to 12 per course of treatment). In 2 (5.4%) cases, due to insufficient patency of the draining pathways, as well as in cases of complete absence of abscess drainage, additional puncture-draining manipulations were used to treat the abscess capsule.

Medical-statistical calculation. The mean value (M) and standard square deviation (SD, σ) were determined: M ± SD. Categorical variables were presented in abso-

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TREATMENT EXPERIENCE OF CHRONIC LUNG ABSCESSES USING MINI-INVASIVE ELECTROSURGICAL TECHNIQUES  **Table I.** Frequency of intraoperative complications in patients of the study groups   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Type of complications main (n=37)** | | | | | **Patient groups**  **comparison (n=41)** | | | **p** | | Pneumothorax | | | 2 (5.4) | | | 5 (12.2) | | 0,436 | | Hemoptysis | | | 1 (2.7) | | | 4 (9.8) | | 0,362 | | Pulmonary hemorrhage | | | 0\* | | | 7 (17.1\*\*) | | 0,012 | | Subcutaneous emphysema | | | 3 (8.1) | | | 7 (17.1) | | 0,317 | | Damage to neighboring organs | | | 0\* | | | 6 (14.6\*\*\*) | | 0,027 | | Generally | | | 6 (16.2) | | | 29 (70.7) | | <0.001 | | Notes: \* – 95 % CI [0-5,1 %]; \*\* – 95 % CI [7,0-30,4 %]; \*\*\* – 95 CI [5,4-27,4 %]  **Table II.** Dynamics of intoxication indicators in patients of the study groups | | | | | |  |  |  | | **Patient groups** |  | **LII, с.u.** | |  | |  | **LI, c.u.** |  | | **Before operation** | **The 5th day** | | **The 14th day** | | **Before operation** | **The 5th day** | **The 14th day** | | Main (n=37) | 4.12 ± 0.23 | 2.92 ± 0.14 | | 1.78 ± 0.18 | | 0.26 ± 0.04 | 0.36 ± 0.04 | 0.41 ± 0.03 | | Comparison (n=41) | 4.05 ± 0.18 | 3.57 ± 0.18 | | 2.03 ± 0.18 | | 0.25 ± 0.03 | 0.28 ± 0.03 | 0.45 ± 0.01 | | p | 0.31 | 0.034 | | 0.16 | | 0.43 | 0.001 | 0.14 | | **Table III.** Instrumental monitoring of the effectiveness of treatment of patients with CAL | | | | | |  |  |  | | **Patient groups**  **Indicators of treatment effectiveness**  **comparison (n=41)** | | | | | | | **main (n=37)** | **p** | | Time to reduce the abscess cavity by 1/4 (days) 12.2 ± 0.54 | | | | | | | 5.5 ± 0.32 | **<0.001** | | Time for reduction of the abscess cavity by 1/2 (days) 22.3 ± 1.05 | | | | | | | 12.5 ± 0.57 | **<0.001** | | Time for complete healing of the destruction cavity (days) 36.07 ± 1.8 | | | | | | | 19.8 ± 0.62 | **<0.001** | | Time to clean the destruction cavity from purulent contents (days) 20.9 ± 0.85 | | | | | | | 7.56 ± 0.62 | **<0.001** | |

lute and percent values (with a 95 % confidence interval [CI]). The probability of differences in the obtained quantitative characteristics in two mutually independent groups was determined using the Mann-Whitney U-test and in mutually dependent groups – the Wilcoxon matched-pairs signed-ranks T-test. Fisher’s F-test probability calculation was also used. The significance level (p) in the study was taken as lower than 0.05. Statistical calculations were performed by the use of IBM SPSS 25.0 and MedStat v. 5.0.

## RESULTS

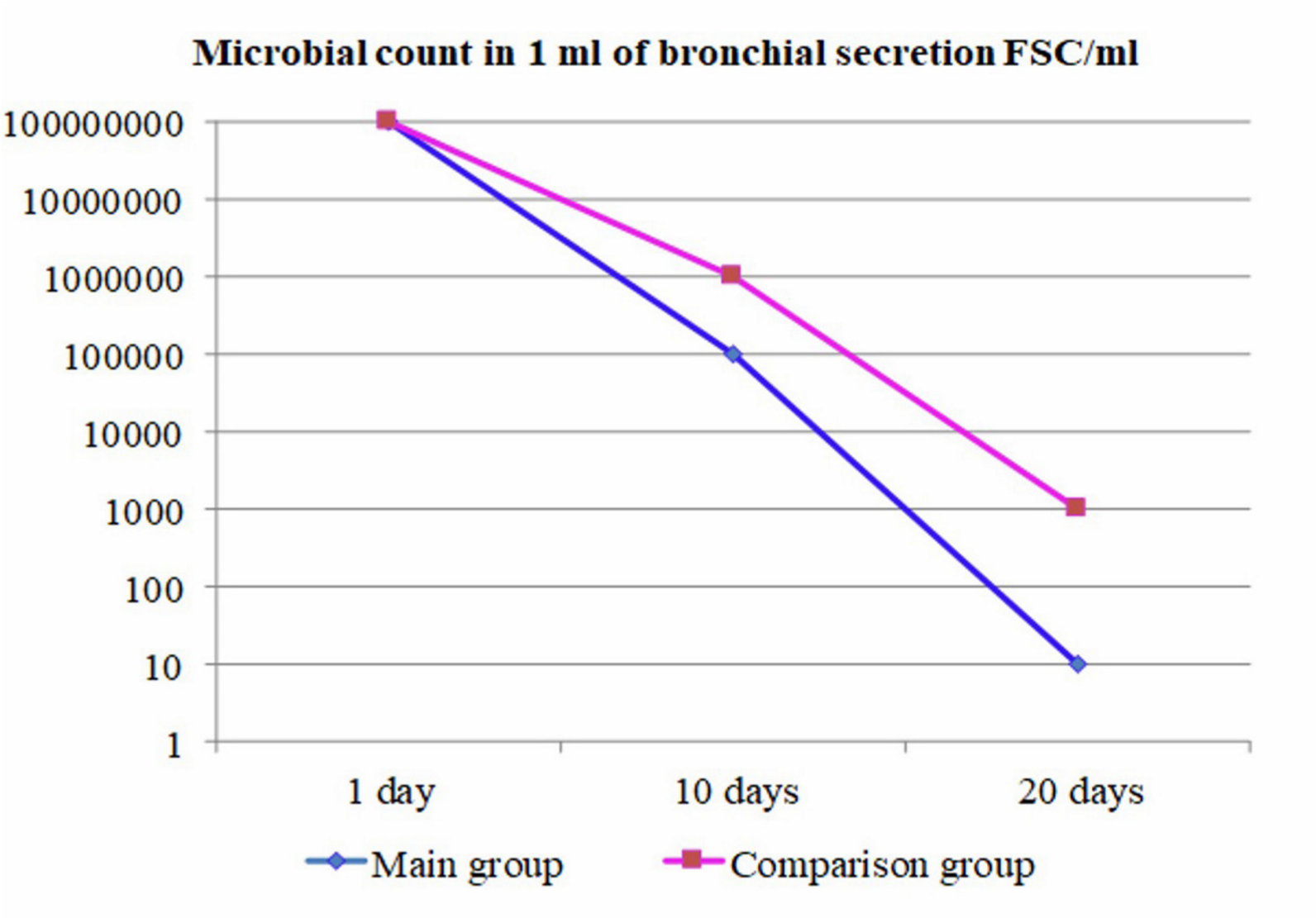
Transthoracic and endobronchial sanation of the purulent cavity in the lung at the first stage of treatment contributed to the rapid elimination of inflammation and significantly accelerated the regeneration of lung tissue. Clinical effectiveness was expressed in reducing the phenomena of intoxication – already on the 3-rd–5th day there was a decrease in hyperthermia and a systematic decrease in leukocytosis.

The indication for the removal of drainage in patients of the comparison group was the cessation of the intake of purulent separable, stable normalization of body temperature, and positive laboratory dynamics of blood parameters. X-ray sign, which was taken into account as a signal to remove drainage – the disappearance of inflammatory infiltration and the reduction in the size of the destruction cavity.

Analysis of postoperative complications is given in Table I.

Before performing draining methods of treatment (transthoracic or endobronchial) in patients of both groups of the study, LII exceeded the level of physiological norms (1.6 ± 0.5 in. units) by 2 times, while no significant intergroup differences were found in this indicator (p > 0.1). A statistically significant decrease in LII in the main group compared to the comparison group was observed as early as on day 5 after surgery (p < 0.05). On Day 14, the LII value in all study groups did not significantly differ from the reference normal range. The difference between LII scores in all study arms was not significant (p > 0.1).

In addition, according to the results of the study, before the mini-invasive intervention for drainage of the purulent cavity, a twofold decrease in LI was noted compared with the norms (0.41 ± 0.03 y. units) in the entire patient pool. This trend of integral indices of the leukocyte formula fully confirms the analytical data of hemograms of transfer blood of patients in the study groups (Table II).



**Fig. 1.**

Microbial number dynam

-

ics in the studied patients.

When assessing the results of bacteriological examination before the start of treatment of the entire pool of patients under study, it was possible to establish the presence of microbial associations in 31.5% of cases and the presence of monoculture in 68.5% of observations. When studying the species composition of the microflora, we found that before the operation, strains of gram-positive pathogens prevailed in sputum patients (61.3%). With repeated bacteriological studies of the isolated already on the 10th day, a significant reduction in patients bacterial excretors was noted: in the main group by 18.9%, in the comparison group – by 14.6%, while statistically significant intergroup differences in the qualitative composition of microflora sown from drains were not established in the described period.

Also, to assess the effectiveness of treatment, we conducted a bacteriological study: and the dynamics of treatment in patients with comparison groups, the microbial number in 1 ml of bronchial washings taken during bronchoscopy was studied. The results obtained are graphically shown in Fig 1.

In patients of the main and comparison group, the microbial number on the 1st day of treatment was approximately the same and amounted to 1x108-9 CFU/ml (colony-forming units in 1 ml). On the 10th day of treatment, the microbial number in the patients of the main group was 1x105 CFU/ ml, which is 10 times less than the microbial number in the comparison group 1x106 CFU/ml at the same time. On the 20th day, the microbial number in patients of the main group reached an average of 1x10 CFU/ml, and in patients of the comparison group at the same time, the microbial number was 1x103 CFU/ml. It should be noted that in 28 (75.7%) cases in the main group, decontamination of the purulent-destructive cavity was achieved. At the same time, the volume of decomposition separated from the cavity decreased systematically from the moment of drainage.

When monitoring the effectiveness of treatment in patients with comparison groups, we evaluated the following indicators over time: the average time to reduce the volume of the destruction cavity by 1/4, 1/2 and its complete healing, the average time to clear the CAL cavity from purulent content. The data obtained by observation are presented in Table III.

Thus, analyzing the data of our dynamic instrumental control over the effectiveness of two fundamentally different methods of treatment of patients with CAL, it is possible to assert that the treatment program proposed in patients of the main group is more effective in comparison with the comparison group. So, in patients of the main group, the average time of reducing the abscess cavity by 1/4 of the volume was 5.5 ± 0.32 days, which is 6 days less (p <0,001) than in patients of the comparison group. The leading indicator we considered the healing time of the cavity of the AL. In patients of the main group, it was 7.56 ± 0.62 days, which is on average 13 and 16 days, respectively, less (p < 0.05) than the same indicator in patients of the comparison group.

## DISCUSSION

|  |
| --- |
| TREATMENT EXPERIENCE OF CHRONIC LUNG ABSCESSES USING MINI-INVASIVE ELECTROSURGICAL TECHNIQUES |

The data obtained by us confirm the opinion of researchers who claim that with the contactless use of argon plasma, antimicrobial properties are noted, a sterilizing effect is created, and the processes of proliferation and regeneration of tissues are accelerated, which contributes to the optimization of the wound process.

So, Deguchi H. [11] conducted a case–control study in 62 patients (34 men and 28 women, median age; 69 years) who underwent APC after endoscopic injection sclerotherapy (EIS) (main group) for hemorrhagic or risky esophageal varices was compared with that of control patients who did not undergo APC after EIS (control group). They determined that APC after EIS was safe and could significantly prevent the recurrence of esophageal varices. They determined that the 1-year and 2-year recurrence rates of the main group were 9.7% and 11.3%, respectively, and the rates of the control group were 29.0% and 34.7%, respectively. Kaplan– Meier curves showed a significantly lower recurrence rate in the main group (p = 0.013, log–rank test).

Loh R. [12] a multi-institutional, retrospective cohort study was conducted, comprising 283 patients who underwent bilateral tonsillectomies. They compare the safety and efficacy of APC and coblation techniques in tonsillectomy. They determined that in the APC group, mean operative time and post-operative hemorrhage rate were significantly reduced, p = 0.0006 and p = 0.003 respectively.

Nam K. [13] were retrospectively reviewed 109 patients who underwent Endoscopic snare papillectomy (ESP) for ampullary adenoma. Using propensity score matching, Nam K. et. al. compared short- and long-term outcomes between the ESP-with-additional-APC group (ESP + APC group) and the ESP-only group. Bleeding rate was significantly lower in the ESP + APC group than in the ESP-only group (7.3% vs 31.7%, OR = 0.180, p < 0.01). However, there were no significant differences in other: pancreatitis (12.2% vs 19.5%, P = 0.365), cholangitis (2.4% vs 9.8%, P = 0.198), and perforation (2.4% vs

### REFERENCES

2.4%, P = 1.000). Papillary stricture (9.8% vs 4.9%, P = 0.405) and recurrence rates (24.4% vs 24.4%, P = 0.797) were not significantly different between the ESP + APC group and the ESP-only group.

## CONCLUSIONS

1. The developed methods of using mini-invasive bronchoscopic and puncture-draining surgical interventions using electrosurgical technologies made it possible to significantly positively affect the level of endogenous intoxication indicators (by 5 days of treatment), reduce the healing time of the abscess cavity from 36.07 ± 1.8 days to 22.6 ± 0.38 with the use of APK (p < 0.05), as well as reduce the level of contamination by 63.9% and 64.9%, as well as avoid resection surgical interventions.
2. The use of minimally invasive bronchoscopic technologies (with centrally located HAL) and puncture-draining (with peripheral HAL) surgical interventions using electrosurgical technologies allowed to reduce the number of postoperative complications from 70.7% to 16.2% when using APK, as well as to avoid damage to neighboring organs.
3. Analysis of the results of mini-invasive surgical methods for the treatment of chronic lung abscesses made it possible to establish that the timely use of mini-invasive endobronchial, puncture-draining techniques using electrosurgical devices can significantly reduce the time of clinical and socio-labor rehabilitation of patients (1.2 times) with the achievement of a stable positive effect, as well as avoid resection methods of surgical interventions and deaths in the postoperative period.
4. F eki W, Ketata W, Bahloul N et al. Lung abscess: Diagnosis and management. Revue des Maladies Respiratoires. 2019;36(6):707–719. doi: 10.1016/j.rmr.2018.07.010.
5. Takaki M, Tsuyama N, Ikeda E et al. The Transbronchial Drainage of a Lung Abscess Using Endobronchial Ultrasonography with a Modified Guide Sheath. Internal Medicine Journal. 2019;58(1):97–100. doi: 10.2169/internalmedicine.9419-17.
6. C hurylin RYu, Voronzhev IO, Kolomiychenko YuA et al. Dyferentsiyna renthenodiahnostyka psevdotuberkul'oznoho varianta abstsesu lehen' z porozhnynamy tuberkul'oznoyi etiolohiyi. [Differential x-ray diagnostics of pseudotuberculosis variant of lung abscess with cavities of tuberculous etiology]. Ukrainian Journal of Radiology and Oncology. 2021;29(1):9–20. doi: 10.46879/ukroj.1.2021.9-20. (in

Ukrainian)

1. M atarese A, Tamburrini M, Desai U, Zuccon U. Percutaneous lung abscess drainage: revisiting the old gold standard. Monaldi Archives for Chest Disease. 2020;90(1):1214. doi: 10.4081/monaldi.2020.1214.
2. T eng E, Bennett L, Morelli T, Banerjee A. An unusual presentation of pulmonary embolism leading to infarction, cavitation, abscess formation and bronchopleural fistulation. BMJ Case Reports. 2018;2018:bcr2017–222859. doi: 10.1136/bcr-2017-222859.
3. Y un SS, Cho HS, Heo M et al. Lung abscess by Actinomyces odontolyticus and Parvimonas micra co-infection presenting as acute respiratory failure. Medicine. 2019;98(35):e16911. doi: 10.1097/md.0000000000016911.
4. M iki M. Standard and Novel Additional (Optional) Therapy for Lung Abscess by Drainage Using Bronchoscopic Endobronchial Ultrasonography with a Guide Sheath (EBUS-GS). Internal Medicine. 2019;58(1):1–2. doi: 10.2169/ internalmedicine.0968-18.
5. Shivachev H, Pahnev Y, Antonova Z et al. Complex minimally invasive approach for complicated parapneumonic pulmonary abscess with bronchopleural fistula in childhood. European Respiratory Journal. 2019;54:PA2218. doi: 10.1183/13993003.congress-2019.pa2218.
6. K onietzke P, Mueller J, Wuennemann F et al. The value of chest magnetic resonance imaging compared to chest radiographs with and without additional lung ultrasound in children with complicated pneumonia. PLOS ONE. 2020;15(3):e0230252. doi: 10.1371/journal. pone.0230252.
7. Brahmavar M, Joshi D, Raman D. Application of Lung Ultrasound in Critical Care Setting: A Review. Cureus. 2019;11(7):e5233. doi: 10.7759/cureus.5233.
8. D eguchi H, Kato J, Maeda Y et al. Argon plasma coagulation is effective for prevention of recurrent esophageal varices after endoscopic injection sclerotherapy: Single-center case–control study. Dig Endosc. 2016;28(1):42–49. doi: 10.1111/den.12538.
9. L oh R, Stepan L, Zhen E, Shaw CL. Argon plasma coagulation tonsillectomy versus coblation tonsillectomy: a comparison of efficacy and safety. J Laryngol Otol. 2019;133(6):520–525. doi: 10.1017/S0022215119001191.
10. N am K, Song TJ, Kim RE et. al. Usefulness of argon plasma coagulation ablation subsequent to endoscopic snare papillectomy for ampullary adenoma. Dig Endosc. 2018;30(4):485–492. doi: 10.1111/den.13008.

*The ethical approval was obtained from Bioethics Committee of the Kharkiv National Medical University. All patients provided written consent to participate in research in accordance with the recommendations of the Ethics Committees for Biomedical Research, Ukrainian Health Legislation and the Declaration of Helsinki of 2000, European Community Directive 86/609 On Human Participation in Biomedical Research.*

*The work is a fragment of research work The Department of the Department of surgery № 1 Kharkiv National Medical University «Development of surgical technologies diagnostics and treatment of diseases and injuries organs of the digestive system using hybrid operations (open and minimally invasive)» (№ state registration 0119U002909), deadline: 2019-2023.*

**ORCID and сontributionship:**

*Аnton A. Serenko: 0000-0002-6410-4509 A, B*

*Vasyl G. Hroma: 0000-0003-1886-3181 B, D*

*Dmytro V. Minukhin: 0000-0003-3371-1178 A, C*

*Denis O. Yevtushenko: 0000-0003-1941-7183 D, E*

*Volodymyr V. Tkachenko: 0009-0004-5194-4340 B, E*

*Vasyl V. Kritsak: 0000-0002-3712-6235 B, C Pavlo I. Korzh: 0000-0002-8904-4629 D*

**Conflict of interest:**

*The Authors declare no conflict of interest.*

## CORRESPONDING AUTHOR

**Anton A. Serenko**

Kharkiv National Medical University 1 Balakirev entr., 61103 Kharkiv, Ukraine tel: +380955334024. e-mail: ant\_sirenko@gmail.com

**Received:** 10.04.2023

**Accepted:** 18.09.2023

**A** - Work concept and design, **B** – Data collection and analysis, **C** – Responsibility for statistical analysis, **D** – Writing the article, **E** – Critical review, **F** – Final approval of the article

Article published on-line and available in open access are published under Creative Com mon Attribution-Non Commercial-No Derivatives 4.0 International (CC BY-NC-ND 4.0)