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RESEARCH ARTICLE

Surgical Treament of the Patients with Pulmonary Tuberculosis using Videothoracoscopic Interventions

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ABSTRACT

Introduction. Pulmonary tuberculosis is a serious problem as in Ukraine as throughout the world. The number of patients with pulmonary tuberculosis is increasing year by year, which is due to the difficulties in early detection of this disease.

The aim. To determine the effectiveness of surgical treatment of patients with pulmonary tuberculosis by using video-assisted thoracoscopic interventions.

Methods. In the Department of Thoracic Surgery of the State University "National Institute of Phthisiology and Pulmonology named after F. G. Yanovsky NAMS of Ukraine" from 2008 to 2022 140 video assisted lung resections were performed in a planned manner for phthisis-surgical patients. The distribution according to the type of resection intervention was as follows: atypical segmental resection - in 30 (21.4 %) cases, typical segmentectomy – in 50 (35.7 %), lobectomy - in 52 (37.2 %), bilobectomy – in 3 (2.1 %), pulmonectomy – in 5 (3.6 %).

The results. The average duration of operative VATS resection interventions was (75.1 ± 22.3) min., intraoperative blood loss was (85.4 ± 1.6) ml, duration of narcotic analgesics prescription in patients with video-assisted thoracoscopic lung resections was (2.20 ± 0.04) days. Early mobilization of patients recorded in 112 (80.0 ± 3.4) cases. The average length of stay of the patient in the intensive care unit after video-assisted thoracoscopic lung resection was (2.6 ± 0.8) days, length of stay of the patient in the hospital in the postoperative period was (12.4 ± 0.5) days. Intraoperative complications were diagnosed in 7 (5.0 ± 1.8) % of patients. The rate of postoperative complications was 22 (15.7 ± 3.1) % of observation. There was no postoperative mortality after minimally invasive surgical interventions. The overall efficiency of performing video-assisted thoracoscopic lung resections was 97.1 %.

Conclusion. The use of video-assisted thoracoscopic is a convenient, effective and low-traumatic method in the treatment of patients with pulmonary tuberculosis. The overall effectiveness of video-assisted thoracoscopic methods for pulmonary tuberculosis was 97.1 %. An adequate assessment of the possibility of performing video-assisted thoracoscopic and the use of methods to prevent complications ensures a predictable course of the intra- and postoperative periods and increases the effectiveness of surgical interventions.

Introduction

Pulmonary tuberculosis (TB) is a serious problem as in Ukraine as throughout the world. The number of patients with pulmonary TB is increasing year by year, which is due to the difficulties in early detection of this disease[1], lack of characteristic, reliable symptoms, asymptomatic or subacute onset of the disease, existing concomitant pathology, low sanitary and medical awareness of the population about this disease. Modern TB is characterized by a number of features, which are concluded in the significant prevalence of drug resistance of Mycobacterium tuberculosis (MBT) to the first- and second-line antituberculosis drugs and broad-spectrum antibiotics which are active against this pathogen[2], that ultimately lead to irreversible morphological changes in the lung tissue . The success of TB chemotherapy in recent years is primarily due to the use of new anti-tuberculosis treatment regimens[3]. However, due to the presence of polydestructive processes in the lung parenchyma and polyresistance to the combination of the main anti-tuberculosis drugs[4], the inability to overcome the disease with only therapeutic treatment is obvious. Under such conditions, the use of thoracic surgical interventions, which have proven their effectiveness[5], allows to improve significantly the results of treatment of TB patients and prevent the further spread of this disease.

The latest trends in the development of surgery are aimed at the use of less traumatic, but more effective surgical interventions, which in thoracic surgery include video-assisted thoracoscopic surgical interventions[6] (VATS). VATS is used to perform typical and atypical segmentectomies, polysegmental resections, combined lung resections, lobectomy, bilobectomy, pulmonectomy, pleurectomy with lung decortication, bulla coagulation, pleurodesis, sanitation and drainage of the pleural cavity, as well as diagnostic biopsy operations[7].

VATS lung resections in resistant forms of TB lungs in practice prove their effectiveness. They are alternative types of surgical interventions in thoracic surgery, have many advantages in compared to classic thoracotomy operations, but is more technically complex surgical interventions. The advantages of VATS-resections in compared to open thoracotomy are: less traumatism of the operative intervention (operative access 5-7 cm long); shorter term stay of the patient in a hospital; less need for p/o analgesia; early mobilization of the patient; the possibility of extending the indications to operational intervention in the elderly and in patients with limited vital capacity functions; minor cosmetic defect.

But VATS interventions have a number of its shortcomings: insufficient control over the operational area intervention; difficulties in the surgeon's manipulations with insufficient collapse lungs; the impossibility of a full palpatory assessment of the state of the parenchyma lungs; difficulties of the surgeon's actions in the presence of a pronounced malignant process in pleural cavity; the technical difficulty of performing a full-fledged mediastinal lymphodissection; the use of expensive surgical tools To resolve the issue of the possibility of successfully conducting VATS- of resections in patients with resistant tuberculosis of the lungs in the preoperative period, it is necessary, according to the data of computed tomography in dynamics evaluate the limits of the spread of the pathological process, make sure in the absence of obliteration of the pleural cavity and the absence of TB impression tracheobronchial tree on the side of the operation.[15-16]

The aim

To determine the effectiveness of surgical treatment of patients with pulmonary tuberculosis by using VATS interventions.

Methods

The research was conducted in the accredited clinic of the State Institution "National Institute of Phthisiology and Pulmonology named after F.G. Yanovsky National Academy of Sciences of Ukraine" (NIFP NAMNU) (Accreditation certificate, higher category, series M3, No. 013556, dated July 21, 2017, registration number 10001).

The object of the study were 140 patients with pulmonary tuberculosis who were operated on using VATS techniques.

The study was conducted on the basis of the Department of Thoracic Surgery and Invasive Diagnostic Methods of the NIFP NAMNU The study was agreed with the ethics committee, the patients were familiarized with the study protocol and signed the informed consent to participate in the study.

In order to solve the research tasks, the data of the electronic database of the "MSIMEDScientific" program of all patients who were treated in the surgical departments of the NIFP NAMNU in the period from 01.01.2008 to 01.02.2022 were analyzed. In order to analyze the number of patients with resistant forms of TB among all TB patients who underwent surgical treatment, and an

accurate analysis of the structure of surgical interventions in patients with resistant forms of TB, in addition to the "Log of recording surgical interventions in the hospital", the annual reports of the NIFP NAMNU were analyzed in the section " clinic" obtained from the open electronic database of NIFP NAMNU. The immediate results of surgical treatment were determined based on the data of the disease histories of the operated patients, during follow-up examinations (after 2-4-6-12 months), as well as according to the data of the National Electronic Register of Tuberculosis Patients. Data on the presence of MBT excretion by the patient were taken into account.

Criteria for including objects of study:

- the presence of established diagnosis of TB;
- operative intervention using VATS techniques;
- the presence of tuberculous pathological changes in the lung parenchyma, including destruction of the lung parenchyma, empyema of the pleura, or postoperative complications that required surgical treatment;
- age of patients up to and including 74 years;
- availability of the patient's informed consent to participate in the study;

Criteria for excluding objects of study:

- failure to comply with the treatment regimen;
- age older than 75 years;
- lack of informed consent of the patient;
- presence of absolute contraindications to surgical treatment;
- refusal to participate in the research at any stage.

The age criterion of up to 74 years was chosen in accordance with the recommendations of the WHO on the classification of human age, according to which age older than 75 years is considered senile.

All VATS lungs resections of the patients were performed in a planned manner after a preoperative course of specific chemotherapy. The term of the preoperative course of specific chemotherapy in the absence of MBT resistance to first-line antituberculosis drugs was 2 months, the minimum term of therapy with second-line drugs with resistant TB was 5 months.

In typical segmentectomies, lobectomies, bilobectomies, pulmonectomies, operations were performed using a minithoracotomy up to 8 cm with video support and subsequent separate processing of all elements of the resected lung root.

The main indications for VATS resection of the lung were:

– by the type of tuberculosis process: newly diagnosed tuberculosis (NDTB); rifampicin-resistant tuberculosis (Rif-TB); multidrug-resistant tuberculosis (MDR-TB); Tuberculosis with extensive drug resistance (EDR-TB);

– by the clinical form of TB: tuberculoma (with or without destruction); limited fibrous-cavernous tuberculosis (FCT) with peripheral location of destruction zones without spreading to the lung root;

– by the localization of destructive changes in the lungs: peripheral location of tubercles and FCT;

– by the number and size of destructive changes in the lungs: single cavities of destruction within the resection zone; multiple destruction cavities within the resection zone; cavities of destruction up to 3 cm in size;

– by the presence of bacterial excretion: MBT (–);

– by the clinical course of TB: stabilization phase;

– by the presence of complications: hemoptysis; pneumothorax.

Contraindications to performing VATS-resection of the lung were: lack of clinical and radiological stabilization of the TB process at the time of the operation; giant caverns; polycavernosis of the lung; basal localization of destruction cavities; somatic pathology in the stage of decompensation; cardiovascular insufficiency; II-III stage respiratory failure.

Parametric and non-parametric statistics methods were used in data analysis. The choice of methods depended on whether the studied numerical series corresponded to a normal distribution. The check was performed using a special function NORMSAMP_1 developed for the Excel program. In our research, we used methods of descriptive statistics. To estimate how much the sample arithmetic mean differed from the general mean, the mean squared deviation was calculated.

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2}.$$

The capabilities of Microsoft Excel were used for evaluation.

Results. The results of surgical treatment of TB patients using VATS lung resections are shown in Table 1.

Table 1. Results of surgical treatment of TB patients using VATS resections

Indicator	Type of operation	
	VATS lung resection (N = 140)	
	abs	M±m
The average duration of the operation (min)	–	75,1 ± 22,3
The average blood loss during surgery (ml)	–	85,4 ± 1,6
The average duration of narcotic analgesics prescription(days)	–	2,20 ± 0,04
Early mobilization of the patient (up to 3 days)	112	80,0 ± 3,4
The average length of stay of the patient in the intensive care unit (days)	–	2,6 ± 0,8
The average length of stay of the patient in the hospital in the postoperative period (days)	–	12,4 ± 0,5
Number of intraoperative complications (% of cases)	7	5,0 ± 1,8
Number of postoperative complications (% of cases)	22	15,7 ± 3,1
Postoperative mortality (% of cases)	0	0,0

Analyzing the data presented in Table 1, we can come to the conclusion that the average duration of operative VATS resection interventions was (75.1 ± 22.3) minutes, the average intraoperative blood loss was (85.4 ± 1.6) ml. The average duration of narcotic analgesics prescription among the patients with VATS lung resections was (2.20 ± 0.04) days. Early mobilization of patients (up to 3 days) was recorded in 112 (80.0 ± 3.4) cases. The average length of stay of the patient in the intensive care unit after VATS lung resection was (2.6 ± 0.8) days, and the average length of stay of the patient in the hospital in the postoperative period was (12.4 ± 0.5) days. Intraoperative complications were diagnosed in 7 (5.0 ± 1.8) % of patients. The level of postoperative complications was 22 (15.7 ± 3.1) % of observation. There was no postoperative mortality after minimally invasive surgical interventions. The overall efficiency of performing VATS lung resections was 97.1 %.

Data on intraoperative and postoperative complications in patients with pulmonary TB after VATS-resections are shown in Table 2.

Table 2. Intraoperative and postoperative complications in patients with pulmonary TB, after VATS resections

Indicator	Type of operation	
	VATS lung resection (N = 140)	
	abs.	M±m
Number of patients with intraoperative complications	7	5,0 ± 1,8 %
Intraoperative bleeding	3	2,1 ± 1,2
Lung parenchyma tears	4	2,9 ± 1,4
Number of patients with postoperative complications	22	15,7 ± 3,1

Long-term underexpansion of the operated lung	5	3,6 ± 1,6
Postoperative (p/o) wound suppuration	4	2,9 ± 1,4
Postoperative exudative pleurisy	5	3,6 ± 1,6
Seroma of soft tissues of the postoperative wound	5	3,6 ± 1,6
Failure of the stump of the bronchus with the formation of a residual pleural cavity	2	1,4 ± 1,0
Hospital pneumonia	1	0,7 ± 0,7
Disease recurrence (% of cases)	4	2,9± 1,4
The overall efficiency of the operation (% of cases)	136	97,1 ± 1,4

The analysis of Table 2 showed that intraoperative complications were diagnosed in 7 (5.0 ± 1.8) % of patients, among which segmental arteries were damaged in 3 (2.1 ± 1.2) % of cases during lobectomy. All these patients underwent emergency conversion to thoracotomy, followed by isolation and suturing of the damaged segmental arteries and application of hemostatic therapy, resulting in stable hemostasis. In 4 (2.9 ± 1.4) % of patients, lung parenchyma tears were recorded as a result of technically difficult pneumolysis; complications were eliminated by suturing the lung parenchyma with U-shaped sutures.

The distribution by the type of resection intervention was as follows: atypical segmental resection in 30 (21.4%) cases, typical segmentectomy in 50 (35.7%), lobectomy in 52 (37.2%), bilobectomy in 3 (2.1%), pulmonectomy – in 5 (3.6%).

The rate of postoperative complications in the studied patients was 22 (15.7 ± 3.1) % of observation. In 5 (3.6 ± 1.6) % of patients, long-term underexpansion of the operated lung was observed. This complication was eliminated by the use of active aspiration, with the application of an artificial pneumoperitoneum and additional drainage of the pleural cavity. In 4 (2.9 ± 1.4) % cases, suppuration of the postoperative wound occurred; the complication was eliminated conservatively with the use of opening the p/o wound and its sanitation with powders, ointments with antibacterial and antiseptic agents. Postoperative pleurisy on the side of the operation occurred in 5 (3.6 ± 1.6) % of patients, which required additional drainage of the pleural cavity. In 5 (3.6 ± 1.6) % of patients, seroma of the soft tissues of the p/o wound area was revealed, which is associated with excessive subcutaneous adipose tissue. In 2 (1.4 ± 1.0) % of patients, after lower lobectomy on the right and lower lobectomy on the left, there was a point (d = 0.5–1.0 mm) failure of the stump of the lower lobe bronchus with the formation of a residual pleural cavity 3 and 5 months after operation. In one case, therapeutic bronchoscopies were performed with the use of medical adhesive solutions at the site of the defect, as a result of which the residual pleural cavity was sanitized and reduced three times in size. Another patient underwent valve bronchoblockage, after 2 months the residual pleural cavity disappeared, the valve was removed. 1 (0.87 ± 0.7) % of the patient was diagnosed with bilateral hospital-acquired pneumonia with abscess after the operation. Correction of antibacterial therapy made it possible to eliminate complications conservatively. Recurrence of the disease was found in 4 (2.9 ± 1.4) % of patients. The main reasons for this complication were: non-compliance with the chemotherapy regime, antisocial lifestyle, resistance of MBT to ATD, overstretching of the operated lung.

The evaluation of the overall effectiveness of the treatment was calculated as the ratio of the number of cases of postoperative mortality and relapse of tuberculosis to the total number of performed operations. The overall efficiency of performing VATS lung resections was 97.1 %.

$$x = \frac{N-(nm+nr)}{N} \text{ x } 100\ \%$$

(140 – (0+4)) / 140 x 100 % = 97.1 %
X – overall effectiveness;
N – total number of operations;
Nm – total number of postoperative mortality;
Nr – total number of disease recurrence.

Discussion.

Closely related to the development of thoracic surgery, TB, once fully-controlled through medical therapy, now emerges again as a threat, considering its MDR-TB and EDR-TB forms. Pneumonectomy is the ultimate therapeutic option for complications of the disease that compromise quality of life.

Patients with failure to medical treatment, persistent cavity with high relapse probability, stenosis, bronchial dilation or atelectasis, associated aspergilloma or repeated hemoptysis are candidates for pneumonectomy.

Tough most of the literature data describes anatomic resections for TB, we find it is a viable procedure through VATS technique, as long some aspects are taken into consideration. The surgeon must properly prepare his patient prior to the procedure. Improving the usual poor health status, taking care the severe adhesions associated with chronic benign inflammatory disease and lymph nodes calcification, carefully identifying all structures and preventing bronchopleural fistula are the main points to be considered. The post-surgical chemotherapy is also of great importance.

In situations where it is difficult to circumvent adhesions and calcification of structures, the intrapericardial vascular ligation may be needed, which may limit thoracoscopy. Completing the surgery with VATS should not be an obligation. The surgeon must use his judgment to consider converting to conventional open thoracotomy, avoiding exceedingly lengthy surgeries because of hard to isolate hilar structures, severe adhesions or local inflammation[17-18].

Analyzing the obtained results, it can be concluded that the causes of intraoperative and postoperative complications in VATS are many different factors and unfavorable factors[8]. Biliary process in the pleural cavity with TB can cause intraoperative bleeding, lung parenchymal tears, damage to the diaphragm, as well as cause intrapleural bleeding in the early postoperative period and long-term underexpansion of the operated lung. Lymphadenopathy in the root of the lung in TB significantly complicates the manipulation of the surgeon on the structural elements of the root of the lung, which can cause bleeding and tears in the lung parenchyma. An insufficiently pronounced interlobular groove increases the probability of damage to vascular structures and lung tissue during surgical manipulations, which in turn can lead to complications and changes in the scope of the operation. Endotracheal intubation and unsatisfactory lung collapse make mobilization of the structural elements of the lung root difficult and complicate for the surgeon to manipulate, and may contribute to bleeding, parenchymal damage, and rib fracture. Performing inadequate access greatly complicates the actions of the surgical team and can become a factor in the development of bleeding, ruptures of the lung parenchyma, and can lead to rib fractures during manipulation with surgical instruments[9].

Obesity contributes to the development of soft tissues seroma, intraoperative fracture of ribs, poor visualization by limiting the amplitude of the surgeon's manipulations. Inadequate drainage of the pleural cavity contributes to the accumulation of exudate in the hemi thorax and the development of postoperative exudative pleurisy on the side of the operation. Contamination of the pleural cavity and soft tissues of the chest wall of the surgical wound, as a result of damage to the pathologically affected parenchyma of the lung and pleura, is the cause of empyema of the pleural cavity and suppuration of the postoperative wound. Hemostasis disorder can be the cause of bleeding and thromboembolic complications. Hospital-acquired pneumonia with abscess is a consequence of inadequate antibiotic therapy, as well as the addition of nosocomial infection in the postoperative period. A long stump of the bronchus and unsatisfactory rehabilitation of the tracheo-bronchial tree contribute to the failure of the stump of the bronchus with the bronchopleural fistula formation and residual pleural cavity.

The combination of these factors increases the probability of the occurence of complications in their various combinations and the expressiveness of their manifestations, which worsens the general condition of the patient, can change the volume of surgical intervention and complicates the postoperative period.

To prevent and eliminate these complications in pulmonary TB, it is necessary to select the patients at the preoperative stage carefully and determine contraindications for conducting VATS interventions[10]. Determining the convenient location of the first thoracoport and intercostal opening for minithoracotomy with the use of small dilators and alternative instruments to dilators is an effective method of preventing intrapleural bleeding, lung parenchymal rupture, and rib fracture. Carrying out a thorough lymphodissection of the lung root contributes to reliable, separate treatment of the elements of the lung root and the strength of mechanical sutures,

which as a result prevents the formation of a bronchial fistula, residual pleural cavities, pleural empyema, intraoperative and postoperative intrapleural bleeding.

Application of U-shaped sutures to the lung parenchyma defects, active aspiration of the contents of the pleural cavity, additional drainage of the pleural cavity, application of artificial pneumoperitoneum is an effective method of prevention and elimination of under expansion of the lung, residual pleural cavities and empyema of the pleura.

With the difficulties in performing surgical manipulations, conversion to a wide thoracotomy is a reliable and effective method that allows you to apply immediately more convenient operative techniques and ensure both the prevention and elimination of bleeding, lung parenchyma tears and diaphragm injuries.

Despite the large number of existing VATS methods, there are few reports in the world scientific literature about the use of video-assisted interventions in the treatment of patients with pulmonary TB. In most of these reports, TB of the lungs is one of the categories (groups of patients) among all nosological forms of the disease, which became an indication for surgical intervention.

According to I.V. Korpusenko's report, the medical histories of 259 patients with bilateral destructive pulmonary tuberculosis were studied in his research. The patients were divided into two groups: the main group - 129 people who were operated on using minimally invasive techniques and the control group - 130 people who were operated on through a wide thoracotomy. According to the results, intraoperative complications during minimally invasive interventions were diagnosed in 2 (1.6 %) patients of the main group and in 7 (5.3 %) of the control group. The average postoperative blood loss in patients of the main group was 394.2±18.7 ml and was 1.4 times less than in the control group (550.8±21.4 ml). Postoperative complications developed in 13 (10.1 %) patients of the main group and in 32 (24.6 %) cases in the control group. Postoperative mortality was 1 (0.8 %) case in the main group and 7 (5.4 %) in the control group. The overall effectiveness of VATS interventions for TB was 87.5 % [11].

According to P. K. Yablonskyi, the level of postoperative complications during VATS interventions for TB was about 15 % [12].

In Hiller's study, 230 resections with the volume of a lobectomy or more were performed on 226 patients with widespread destructive TB of the lungs. In the main group - (126 patients), 130 surgical interventions were performed using the VATS technique, in the control group - (100 patients), 100 resections were performed using standard techniques. When using the VATS technique, intraoperative blood loss was 2.8 times lower, hemotransfusions were absent, narcotic analgesics were not used in 80 % of cases, postoperative complications were 2.7 times less, no mortality, and the effectiveness of treatment was higher [13].

Bédat B. reports that among 690 oncological patients operated on using VATS methods, various complications were diagnosed in 33.3 %, which reliably correlates with these indicators in surgical interventions for pulmonary TB [14].

Conclusions.

1. The use of VATS is a convenient, effective and minimally traumatic method in the treatment of patients with pulmonary tuberculosis.
2. The overall effectiveness of VATS methods for pulmonary tuberculosis was 97.1 %.
3. An adequate assessment of the possibility of performing VATS and the use of methods to prevent complications ensures a predictable course of the intra- and postoperative periods and increases the effectiveness of surgical interventions.

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References

1. *Туберкульоз в Україні : Аналітично-статистичний довідник* / ДУ «Центр громадського здоров'я МОЗ України». Київ, 2019. 45 с. (Tuberculosis in Ukraine: Analytical and statistical guide / State University "Public Health Center of the Ministry of Health of Ukraine". Kyiv)
2. Фещенко Ю. І., Мельник В. М., Ільницький І. Г. *Основи клінічної фтизіатрії*. Київ, 2007. 1173 с. (Feshchenko Yu. I., Melnyk V. M., Ilnytskyi I. G. Basics of clinical phthisiology. Kyiv, 2007. 1173 p.).
3. Перспективи покращення ефективності лікування у хворих на мультирезистентний туберкульоз: світові тенденції та вітчизняні досягнення / Ю. І. Фещенко та ін. // *Інфекційні хвороби. 2017. № 4* (90). С. 10–21. (Prospects for improving the effectiveness of treatment in patients with multidrug-resistant tuberculosis: global trends and domestic achievements / Yu. I. Feshchenko et al. // Infectious diseases. 2017. No. 4 (90). P. 10–21.)
4. Корецкая Н. М. Эпидемиология, патогенез и патоморфология остропрогрессирующего туберкулеза легких // *Сибирский медицинский журнал*. 2011. Т. 101. № 2. С. 5–8. (Koretskaya N. M. Epidemiology, pathogenesis and pathomorphology of acutely progressive pulmonary tuberculosis // Siberian Medical Journal. 2011. V. 101. No. 2. S. 5–8.)
5. Surgical treatment for chronic lung and thoracic cavity infection / M. Kaneda et al. // Gen. *Thorac. Cardiovasc. Surg*. 2009. № 2 (57). P. 98–103.
6. *Видеотехнологии в торакальной хирургии* / Ю. Л. Шевченко и др. // Альманах клинической медицины. 2007. № 16. С. 214–216. (Video technologies in thoracic surgery / Yu. L. Shevchenko et al. // Almanac of Clinical Medicine. 2007. No. 16. S. 214–216.)
7. *Эффективность выполнения видеоассистированных анатомических резекций легких* / Д. Б. Гиллер и др. // Российский медико-биологический вестник им. акад. И. П. Павлова. 2014. №1. С. 126–130. (Efficiency of video-assisted anatomical lung resections / D. B. Giller et al. acad. I. P. Pavlova. 2014. No. 1. pp. 126–130.).
8. Pramesh CS, Mistry RC, Tandon SP. Video–assisted thoracoscopic surgery for pulmonary tuberculosis. J. *Thorac. Cardiovasc. Surg*. 2005;(6):1732–1733. doi: 10.1016/j.jtcvs.2005.08.024. Available at: https://pubmed.ncbi.nlm.nih.gov/16308034/
9. Спосіб вибору доступу при відеоасистованих резекційних втручаннях на легені: пат. 142933 Україна. № u 201910548; заявл. 23.10.2019; опубл. 10.07.2020, Бюл. № 13 (кн. 1). 7 с. (The method of access selection during video-assisted lung resection interventions: pat. 142933 Ukraine. No. u 201910548; statement 23.10.2019; published 10.07.2020, Bul. No. 13 (book 1). 7 p.)
10. Augustin F, Maier H, Lucciarini P. Extended minimaetlly invasive lung resections: VATS bilobectomy, bronchoplasty, and pneumonectomy. **Langenbeck's Archives of Surgery**. 2016;401(3):341–348. doi: 10.1007/s00423-015-1345-4. PMID: 26420241. Available at: https://pubmed.ncbi.nlm.nih.gov/26420241/
11. Корпусенко И. В. Результаты применения миниинвазивных операций при лечении пациентов с двусторонним деструктивным туберкулезом легких // *Новости хирургии*. 2015. №4. (Korpusenko I. V. The results of the use of minimally invasive operations in the treatment of patients with bilateral destructive pulmonary tuberculosis // News of Surgery. 2015. No. 4.) URL: https://cyberleninka.ru/article/n/rezultaty-primeneniya-miniinvazivnyh-operatsiy-pri-lechenii-patsientov-s-dvustoronnim-destruktivnym-tuberkulezom-legki
12. Thoracoscopic lobectomies for TB and non-TB pulmonary diseases: What differences between RATS and VATS technique / G. Yablonskii et. al. // *European Respiratory Journal*. 2016. Vol. 48. Issue 60. P. 2495.
13. Эффективность выполнения видеоассистированных анатомических резекций легких / Д. Б. Гиллер и др. // *Российский медико-биологический вестник им. акад. И. П. Павлова*. 2014. №1. С. 126–130. (Efficiency of video-assisted

anatomical lung resections / D. B. Giller et al. acad. I. P. Pavlova. 2014. No. 1. pp. 126–130.).

14. Comparison of postoperative complications between segmentectomy and lobectomy by video-assisted thoracic surgery: a multicenter study / Bédat B. et al. // J/ *Cardiothorac. Surg*. 2019. Nov. *7* ; 14 (1) : 189. doi: 10.1186/s13019-019-1021-9. PMID: 31699121; PMCID: PMC6836384.
15. . Luh K. Center for Disease Control. Taiwan Guidelines for TB Diagnosis & Treatment. Center for Disease Control, Taiwan, 5th edKaohsiung, Taiwan:2013.
16. . Wu MH, Lin MY, Tseng YL, et al. Results of surgical treatment of 107 patients with complications of pulmonary tuberculosis. *Respirology* 1996; 1:283–289.
17. Shiraishi Y, Katsuragi N, Kita H, et al. Aggressive surgical treatment of multidrug-resistant tuberculosis. *J Thorac Cardiovasc Surg* 2009; 138:1180–1184.
18. Man MA, Nicolau D. Surgical treatment to increase the success rate of multidrug-resistant tuberculosis. *Eur J Cardiothorac Surg* 2012; 42:e9–12. Yew WW, Leung CC. Management of multidrug-resistant tuberculosis: Update 2007. *Respirology* 2008; 13:21–46.