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Research Article

Immediate and Long-Term Results of Surgical Treatment of Postoperative Bronchopleural Complications in Patients with Pulmonary TB

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Abstract

Recent indications for surgical treatment of tuberculosis (TB) are considered by most surgeons as follows: the absence of the effect of chemotherapy for 6 - 12 months with continued bacterial excretion; drug intolerance; complications of TB (aspergillosis, cicatricial stenosis of the bronchi, destroyed lung, recurrent hemoptysis and bleeding, bronchiectasis, the presence of tuberculous empyema of the pleura with or without bronchial fistula (BF), pneumothorax, specific mediastinitis), as well as a suspicion of concomitant lung cancer [4,8-13,18,21,22].

Keywords: *Tuberculosis (TB); Bronchial Fistula (BF); Pneumothorax*

Introduction

The presence of drug resistance of mycobacteria is considered at the same time as a factor enhancing the listed indications. Back in 1974, L.K. Bogush drew attention to the fact that complications often arise after operations with drug-resistant TB [1]. Publications of subsequent decades have confirmed this position [2,5,15,19], showing a particularly high level of complications, which in many cases are fatal, after pneumonectomies.

When analyzing literature data on the surgical treatment of drug-resistant forms of pulmonary TB, the incidence of postoperative complications varied within a very wide range from 10% to 39%, as did postoperative mortality (from 0 to 12.5%). More homogeneous were the data on the high efficiency of surgical treatment, which exceeded 90%. However, the statistical reliability of the published studies was not high due to the small number of observations in each of them. Only in two works, the number of observations exceeded 100 cases (Table 1).

One of the most serious complications after pneumonectomy is the main bronchial stump failure (MBSF) with the development of bronchopleural fistula and empyema of the residual cavity (ERC), the frequency of which varies from 2 to 30% of the operated patients. Despite the successes achieved in the treatment of postoperative bronchopleural complications, mortality in FMBS reaches 50 - 70%.

The main factor in the development of residual cavities after lung resection is the mismatch between the volumes of hemithorax cavity and remaining lung tissue, and the delayed expansion of the lung. Provided that in the pleural cavity after lung resection there remains a

Author and year of publication	Country	Recruitment time	Total number of patients	Postoperative complications	Postoperative mortality rate	Favorable outcome (cure/completion of chemotherapy according to WHO criteria)
B. Xie, 2013 [25]	China	1993-2011	43	23.3%	0%	93%
M. Kang, 2010 [14]	South Korea	1996-2008	72	15%	1.4%	90%
Y. Shiraishi, 2009 [23]	Japan	2000-2007	56	16%	0%	95%
R. Naido, 2007 [17]	South Africa	1997-2005	27	26%	0%	93%
A. Kir, 2006 [16]	Turkey	1993-2005	79	39%	12.5%	95%
S. Takeda, 2005 [24]	Japan	1988-2003	26	23%	3.8%	89%
B. Pomerantz, 2001 [20]	USA	1983-2000	172	12%	3.3%	90%
D. Yu, 2009 [26]	China	1980-2007	133	17.3%	2.3%	90.2%
I.I. Enilenis, 2010 [3]	RF	2004-2006	70	10%	0%	95.7%
M. Bouchikh, 2013 [10]	France	1995-2010	29	31%	3.4%	88.2%

Table 1: *Literature analysis on the surgical treatment of multiple and extensive drug-resistant pulmonary TB (MDR/XDR-TB).*

small volume of lung tissue with the presence of focal tuberculous changes in it, there is a high risk of progressing the specific process in postoperative period [25,29].

To eliminate the residual post-resection space, it was proposed to fill it with various materials (wax seal, lucite balls, ivanol sponge, foam rubber, dacron, teflon, Kel-F, gelatin sponge, bioplastics, etc.), but the use of most of them often causes suppuration, bronchial fistulas. Thoracoplasty in combination with lung resection is important for eliminating post-resection residual space and preventing postoperative disease relapse [25,29].

Treatment of patients with postoperative bronchopleurothoracic complications is very difficult, multi-stage, rather traumatic and in many cases sometimes ineffective. Since 2015, in the thoracic department of the RSSPMCFiP of the Ministry of Health of the Republic of Uzbekistan, there worked out the algorithm for the management of patients with postoperative bronchopleurothoracic complications, depending on the presence and severity of these complications, their combinations, on the general status of the patient. This article is devoted to the study of immediate and long-term results of treatment of patients with postoperative bronchopleurothoracic complications.

Materials and Methods

Here conducted a retrospective analysis of case histories of 91 patients with pulmonary TB, re-operated with various postoperative bronchopleural complications in the thoracic department of the RSSPMCFiP MHRUz over 2013 - 2018 year.

59 (64.8%) men and 32 (35.2%) women were operated on at average age of 39.9 years. Of the total number of these patients, 24 (26.4%) were operated on in other medical clinics.

Initially, bilateral lung lesions were in 22 patients, unilateral destructive lesions were in 69 patients, including the lesions on the right in 48 patients, on the left in 21 patients. According to the clinical forms, there were patients with tuberculomas (11), fibro-cavernous TB (71), cirrhotic TB (7) and caseous pneumonia (2).

At the time of surgery, 52 patients were bacillary. Data on drug sensitivity (DS) of *Mycobacterium* TB (MBT) before the first operation were obtained in 77 patients, including 42 patients who had sensitive forms of MBT, multiresistant forms (MDR-BT) in 2 patients with multidrug- resistance MBT (MDR-BT) - in 31 patients with extensive drug resistance of MBT (XDR-BT) in 16 patients (determined by the methods of Gene Xpert; HAIN test; BACTEC 360).

The first surgery was performed in 33 patients according to emergency or urgent indications, including 4 pulmonary hemorrhages, recurrent hemoptysis in 12, with empyema in 12, and 5 patients with pneumothorax.

Bronchopleurothoracic complications developed after segmental resections in 5 patients, polysegmental resections in 15 patients, lobectomy/bilobectomy and after combined resections of large volume in 28 patients (lobectomy/bilobectomy+ segment), after simultaneous bilateral lung resections in 1 patient, resections of lungs with pleurectomy in 18 patients, after pneumonia/pleuropneumonectomy in 20 patients, transsternal interventions on the main bronchi in 2 patients, cavernoplasty with thoracoplasty - 1 and after cavity wall suturing - in 2 patients.

The postoperative period, complicated by a residual cavity - 44, pleural empyema without bronchial fistula - 4, pleural empyema with bronchial fistula - 25, pleural empyema and foreign body - 3, main bronchus stump failure - 2, bronchial fistula with chest wall defects - 14.

In 33 patients, the pulmonary TB process was accompanied by 49 different concomitant diseases. Among them, chronic hepatitis B and C - 26, diabetes mellitus - 8, pathologies of the cardiovascular system - 7, pathologies of the respiratory system - 2 and the gastrointestinal system - 2, neurological diseases - 1, urological pathology - 1, autoimmune thyroiditis - 1, amputation of both lower limbs - 1.

In 17 patients there were respiratory failure types 2-3, in 6 patients 0-1, weight loss occurred in 11 patients, and in 12 patients with postoperative complications where the tuberculous process spread to the contralateral healthy lung.

In relation to extensive, bilateral nature of the lesion and low functional reserves in most patients, in all cases, after preliminary preparation and stabilization of patients' general condition, one-stage (76), two-stage (12), three-stage (2) and in one patient bilateral staged surgery interventions were used. A total of 108 patients underwent 108 operations (by 1,2 operations per patient). The volumes of repeated surgeries to eliminate bronchopleurothoracic surgery are presented in table 2.

Volumes of Surgery	Total	Right	Left
Transsternal interventions on MB	15	11	4
Circular resection of trachea bifurcation	1	1	-
Transpleural MB stump removal	4	3	1
Resternotomy, suturing of MB stump defect after TOMB	2	2	-
Sternotomy, debridement and drainage of the	1	-	1
Thoracomioplasty with m. latissimusdorsi on the vascular pedicle anterior mediastinum	5	3	2
Thoracomioplasty with m. intercostalis	2	2	-
Resection of the lungs (lobectomy, lobectomy + segmentectomy, polysegmental resection) with pleurectomy	4	3	1
Pneumonectomy or pleuropneumonectomy	16	9	7
Pleurectomy and decortication	1	1	-
VATS extrapleural thoracoplasty	57	32	25
Total	108	67	41

***Table 2**: Volume of repeated surgeries performed.*

Results and Discussion

Transsternal occlusions of the main bronchi (TOMB) were performed (15) according to the following indications: in case of inconsistency of stitches of MB stump after pneumonectomy (1), chronic bronchopleurothoracic (2) and bronchopleural fistulas (1) with empyema after pneumonectomy, with multiple chronic bronchopleural (3) and bronchopleurothoracic (8) fistulas after lung resections with irreversible changes in the parenchyma of the operated lung, as a preliminary stage of multi-stage treatment. In 11 patients, transsternal occlusions were performed on the right side and in 4 patients on the left. These patients are considered as the most severe contingent of patients. Moreover, drug-resistant forms of MBT were found in 12 out of 15 patients, of which: in 8 MDR-TB, in 4 XDR-TB; 5 patients had bilateral destructive pulmonary TB, diabetes was diagnosed in 3, chronic viral hepatitis was detected in 3 patients, 2-3 degree of respiratory failure and heart failure were in 8 patients, severe cardiovascular diseases were diagnosed in 5 patients.

A distinctive feature of our transsternal occlusions of the main bronchi from surgery by L.K. Bogush technique are: the surgery is performed without opening the pericardial cavity in the aortacavalic space, MB stump is sutured manually according to the method proposed by the author of this article, Professor D. B. Giller and MB stump is hidden under the tissue by the remnants of thymus gland.

After TOMB within one to three months, the second stage of surgery is performed: pleuropneumonectomy (9), transpleural removal of MB stump p (2), thoracoplasty (1). A month later, two of these patients with drug-resistant TB of single lung were performed the third stage of surgery VATS extrapleural thoracoplasty on the side of pleuropneumonectomy with the aim of preventing post-pneumonectomy syndromes and endogenous reactivation of specific process in the long term; three patients no performed the next stage of surgery due to: one patient had the progression of specific process in a single lung, the another patient had bronchial fistula relapse and one patient died on the first day after surgery from pulmonary embolism. The direct effectiveness of this method was 80%. During the five-year follow-up period, three patients died: from the progression of the TB process (1), from the progression of respiratory failure (1), from aspiration pneumonia of a single lung (Mendelssohn syndrome). 11 (73.3%) patients are alive and well to date.

One patient underwent circular resection of tracheal bifurcation, which was illustrated as a case of own observation, to eliminate the bronchopleurothoracic fistula after pneumonectomy with complicated inconsistency of the stitches of the right MB stump.

Patient KR 31 years old.

The patient has been suffering from pulmonary TB for the last 12 years. In the family, the father died of pulmonary TB. In the 10th year of disease, he is found to have drug-resistant MBT; he has been taking anti-TB drugs for two years under the MDR-TB treatment program and completes the course of treatment with an unfavorable result. However, at the end of MDR-TB course of treatment the patient is found to have XDR-BT, but due to the absence of XDR-TB treatment program in the country at that time, the patient did not receive appropriate treatment.

On admission to the surgical department, the condition was regarded as moderate. During auscultation in the lungs on the right against the background of dry and finely bubble moist rales, amphoric breathing is heard. The respiratory rate per minute has been 22 times. MSCT of the chest organs has determined a giant cavity in the upper parts of the right lung, and polymorphic foci of different sizes and intensities in other sections (Figure 1).

Sputum microscopy - MBT +. Drug susceptibility tests, Gene Xpert - R-R; HAIN - H, R-R; from the culture of MGIT and Levenshtein-Jensen - H, R, Ofx, Km, Am, Cap - R. Functional lung investigations: VC - 52%; FEV1 - 32%. Fibrobronchoscopy - Catarrhal endobronchitis of 1 degree.

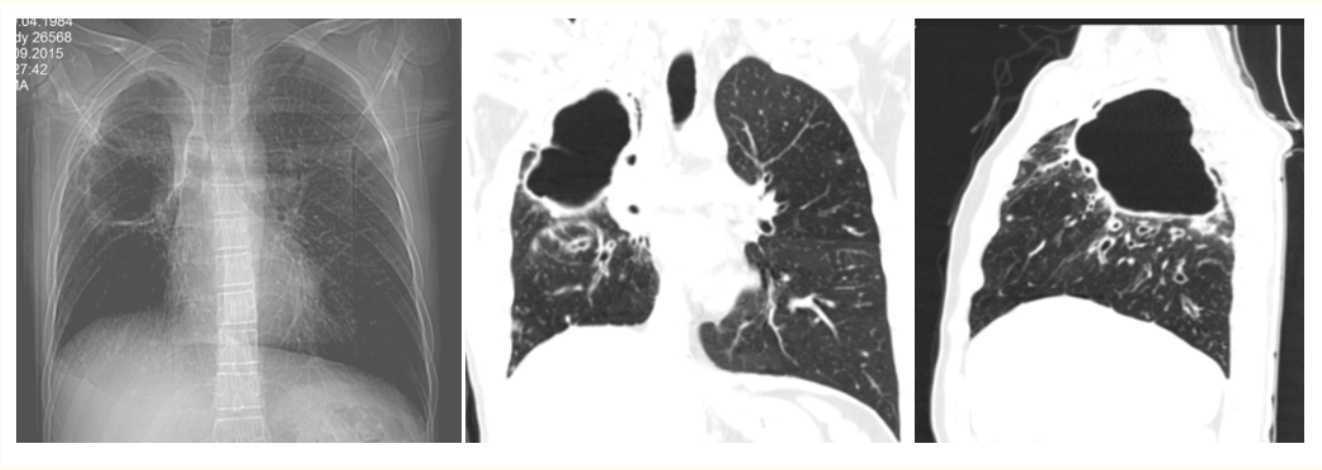

Figure 1: *MSCT of the chest organs of K.R patient before pneumonectomy.*

Clinical diagnosis: Fibrous-cavernous TB of the right lung in the phase of infiltration and seeding. MBT +. XDR TB (H, R, Ofx, Km, Am, Cap - R).

The patient underwent surgery - pneumonectomy on the right. On the 18th day after pneumonectomy, the condition worsened sharply, symptoms of severe respiratory and vascular insufficiency with intoxication and hyperthermia appeared. Air bubbles and pus began to come out of the drainage tube installed in the right pleural cavity. On chest X-ray, there is a condition after pneumonectomy on the right, where the residual cavity is filled with air and liquid with a level (Figure 2).

Figure 2: *Survey X-ray of the chest of the K.R patient on the 18th day after pneumonectomy on the right..*

FBS - condition after pneumonectomy on the right, total failure of stitches of the right main bronchus stump (Figure 3).

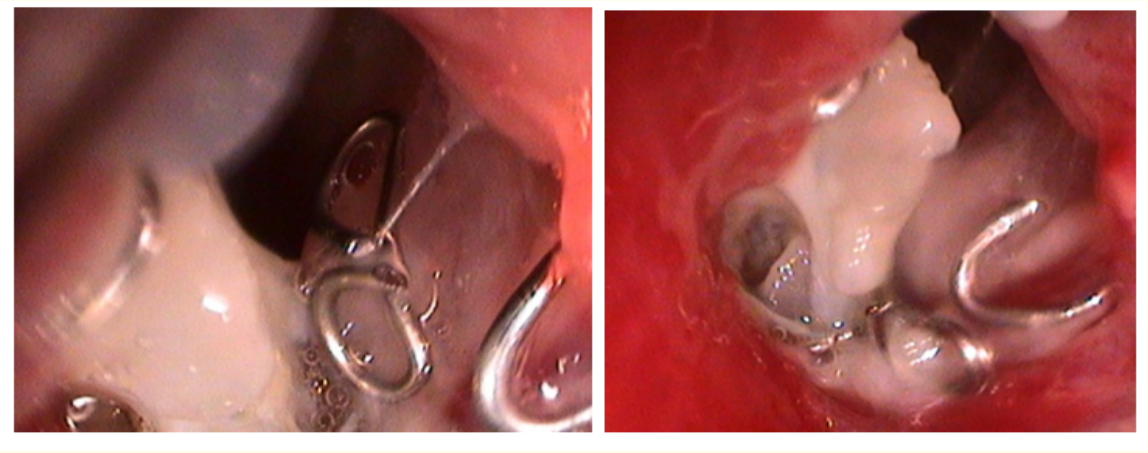

Figure 3: *FBS patient K.R. on the 18th day after pneumonectomy on the right.*

Repeated MSCT of the chest organs showed a condition after pneumonectomy, air and fluid in the right pleural cavity; in a single left lung multiple polymorphic lesions (Figure 4).

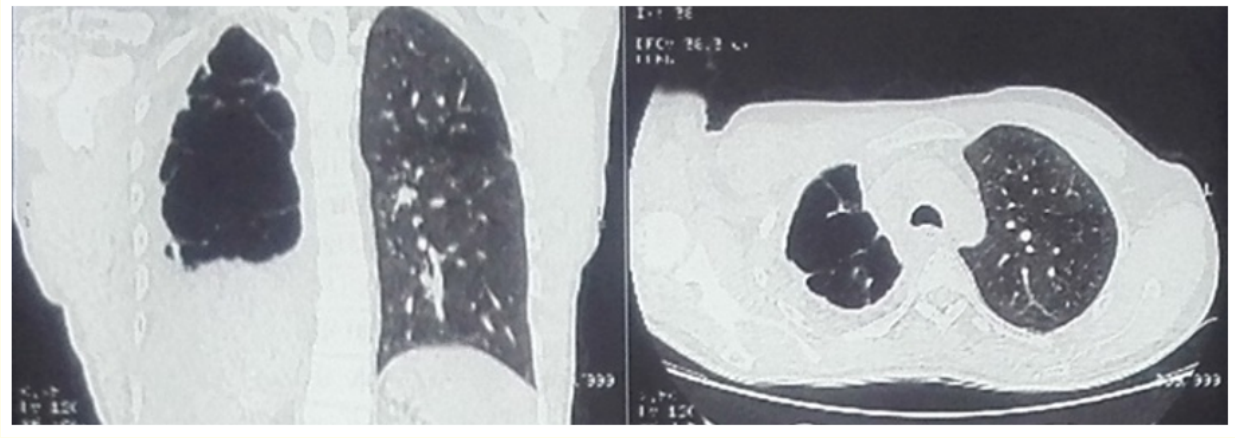

Figure 4: *MSCT of the chest organs in a patient K.R. after pneumonectomy on the right.*

The main reason for the development of the MBSF the main bronchus stump failure can be considered inadequate treatment of XDR-TB. After the introduction of XDR-TB treatment program in the Republic, the patient started treatment under XDR-TB treatment program.

After stabilization of the general condition of the patient within ECOG 3 and stabilization of a specific process in a single left lung, a month later, after the development of MBSF, the patient was performed surgery to eliminate the bronchopleurothoracic fistula - trans-sternal resection of trachea bifurcation with the end-to-end tracheobronchial anastomosis. The area of the anastomosis is additionally

covered with fiber from the remnants of the thymus gland. During the operation, there was detected the defect of trachea right lateral wall *in situ* of the right main bronchus, mechanical sutures from the first operation are not detected, the defect extends to the membranous part of the trachea. The stages of surgery are shown in figure 5.

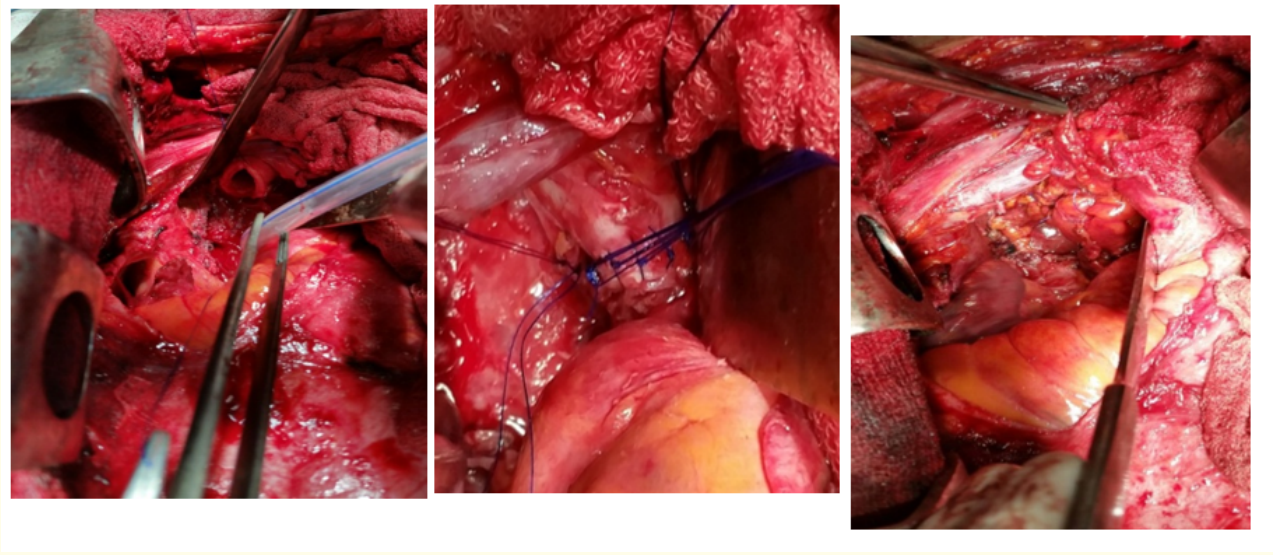

Figure 5: *The stages of surgery of K.R. patient.*

The postoperative period was uneventful, no complications were noted. The patient was discharged from the department 4 months after a circular resection of the tracheal bifurcation with a recommendation to continue the treatment program for XDR-TB domiciliary. In the long three-year follow-up period, the patient completed the full course of therapy for XDR-TB, no recurrence of TB was found, and feels satisfactory.

One patient with a right-sided chronic bronchopleural fistula and another patient with a left-sided bronchopleural fistula after pneumonectomy underwent transpleural re-amputation of MB stump with separate treatment of the vessels of lungs' root and manual processing of the MB stump according to the procedure adopted in our clinic. The main indication for performing such a surgery was "device pneumonectomy" - applying the device to all elements of the lung root without separate processing of the latter (according to published data) while the long stump of the bronchus becomes a reservoir of infection and leads to the development of bronchial fistula in up to 100% of cases. The first patient with drug-sensitive MBT has recovered and is currently feeling satisfactory. Another patient with multiple drug-resistant MBT, with bilateral destructive pulmonary TB and concomitant chronic viral hepatitis C, was transferred to the course of therapy by XDR- TB treatment program in the distant period, but he died in a year after surgery from acute cardiovascular pathology.

In two patients, on the 3rd and 12th day after transsternal occlusion of the main bronchi produced due to the length of the saccular stump of the right main bronchus after pneumonectomy in one patient, and bilateral destructive pulmonary TB (with total destruction of the right lung) complicated by massive pulmonary hemorrhage, XDR-TB developed partial stitches of the stump of the main bronchi. In both cases, there was a concomitant disease - viral hepatitis C, with a transition to cirrhosis in one case. After ineffective conservative measures, both patients underwent a resternotomy, suturing the stump defect of the main bronchi by plasty with parapericardial grafts. The patient with bilateral destructive pulmonary TB (with total destruction of the right lung) complicated by massive pulmonary hemor-

rhage, XDR-TB from mediastinitis and erosive bleeding from a stump of the right pulmonary artery, which was also ligated during the first operation, died on the 5th day after a resternotomy. Another patient was discharged home in satisfactory condition; during the long-term observation period he lives and occupies in governmental work without relapse of TB process.

The next patient with cavernous left lung TB diagnosis, drug-sensitive MBT underwent non- radical surgery (cavernoplasty with posterior upper thoracoplasty) at the place of residence. After surgery the patient was developed fulminant progression of TB process, hematogenous seeding on both sides, with the development of caseous pneumonia on the left and cavernous TB on the right, complicated by left-sided pleural empyema, bronchopleural thoracic fistula on the left and purulent mediastinitis. The patient was admitted to our department in severe condition and the first step was sternotomy, debridement and drainage of the anterior mediastinum, from the removed purulent masses were found on HAIN e - multiresistant MBT. After appropriate preparation (stabilization of general condition, adequate anti-TB therapy, correction of disorders of the respiratory and cardiovascular systems), the second operation was performed - pleuropneumonectomy on the left with plasty of pleurothoracic fistula with local tissues. The postoperative period was wave-like with periodic deterioration of general condition, with hemodynamic disturbances, progression of a specific process, despite the intensive adequate anti-TB treatment, the patient died 6 months after pleuropneumonectomy from the progression of TB process on a single right lung.

Five patients with chronic bronchopleural thoracic fistulas after pneumonectomy were performed thoracoplasty using m.latissimus dorsion vascular pedicle. Indications for such operations were - a single fistula whose diameter is less than 0.4 cm, cleaned pleural cavity with tamponade through the formed thoracostomy or an infected pleural cavity, but without empyema, the patient's general condition corresponds to ECOG 0-1-2. The operation was performed in 3 patients on the right lung and 2 patients on the left one. Bilateral widespread TB was observed in three patients; in all cases, drug-resistant forms of MBT were detected (MDR-TB - 4 cases and XDR-TB in 1 case). Two patients were diagnosed with a concomitant disease of chronic viral hepatitis C. The immediate effect was satisfactory, in one patient in the postoperative period there was an exacerbation of TB process in a single lung. During the first year of follow-up, two patients died, another patient died a year after surgery due to progression of TB process. One patient developed TB process reactivation during the five-year follow-up period and today he is taking treatment under XDR-TB treatment program. One patient for a five-year follow-up period feels satisfactory.

Two patients after lobectomy and combined resection (lobectomy + bisegmentectomy) developed empyema of the residual cavity with bronchial fistula. One patient has XDR-TB, and another has drug-sensitive pulmonary TB. In both patients, concomitant chronic viral hepatitis (B and C) was detected. To eliminate complications in a patient with XDR-TB with completed combined resection, a two-stage surgery was performed (lung removal and thoracoplasty of bronchial defect with a m.intercostalis flap). Another patient underwent one-stage surgical treatment (thoracoplasty of bronchial defect with a flap of m.intercostalis). The immediate effect is satisfactory, the long-term period of two years follow-up, both patients completed treatment courses without relapses.

In three patients after segmental resections and in one patient after lung lobectomy, the postoperative period was complicated by empyema of the pleural cavity with BF (1) and without BF (2), bronchopleural fistula (1). To eliminate these complications, patients underwent lung resection with pleurectomy (lobectomy (1), lobectomy + segmentectomy (1), polysegmental resection (2). The cause of empyema in two cases was the left foreign body during the first operation (in another medical clinic). The patient had concomitant chronic viral hepatitis C against the background of developing bronchopleural fistula. Immediate and long-term results are satisfactory, patients are healthy without relapse.

Pneumonectomy for the elimination of bronchopleural complications was used in 5 cases, after lobectomy (3) and polysegmental resection (2). In all cases, irreversible changes took place in the parenchyma of the operated lung (atelectasis, multiple tuberculous foci and destruction). Three patients were diagnosed with MDR-TB and one patient had bilateral fibro-cavernous TB. In the long-term period, one patient died due to progression of TB process in a single lung, other patients recovered and without relapses.

Rethoracotomy total pleurectomy with decortication of the right lung was performed in one patient with limited postoperative empyema without BF with satisfactory immediate and long-term results.

The largest group of surgeries performed to eliminate postoperative complications was VATS extra pleural thoracoplasty, which was performed 54 times in 53 patients; on the right in 30 patients, on the left in 22 and on both sides in one patient. This technique was developed by one of the authors of this article, Professor D. B. Giller (2008), and has many advantages than the classic thoracoplasty proposed by F. Sauerbruch (1912): less traumatic, quite effective for lung collapse, does not disturb the function of the upper limbs, the frequency of postoperative surgical complications minimized, does not require wearing pressure dressings for a long time, quick rehabilitation of patients, and most importantly, because of the aesthetics of this surgery, patients do not need to be persuaded for a long time to perform it. It is removed according to indications from 3 to 6 ribs. The indications for the performance of VATS of the posterior thoracoplastics for the elimination of bronchopleural complications were: functioning BFs after pneumonectomy (6) and after extensive lung resection (2); residual cavity (45); after non-radical surgery (1, cavernoplasty). In 32 patients the tuberculous lesion was unilateral, in the remaining 21 patients it was bilateral, DS MBT was detected in 29 patients, PDR MBT in 1 patient, MDR MBT in 16 patients, XDR MBT in 7 patients. The immediate effectiveness (elimination of postoperative BFs, pleural empyema, residual cavity) of the extracorporeal thoracoplasty VATS was about 92.5%. The effectiveness of this method is illustrated in the following observation.

The patient K Sh 21 years old.

He has been registered at the dispensary for about 8 months - TB of the upper lobe of the right lung with primary multiple drug-resistant MBT. A patient with a clinical diagnosis of fibrocavernous TB of the right lung upper lobe. MBT+.MDR MBT, it was performed upper lobectomy of the right lung. In postoperative period, the patient retained a residual cavity in the upper pleural cavity, which was imaged both on the chest x-ray and on MSCT of the chest organs (Figure 6).

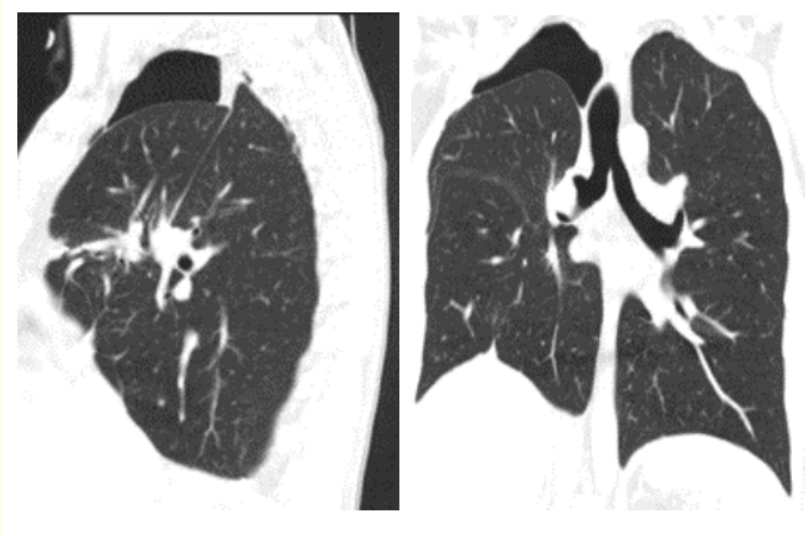

Figure 6: *MSCT of the chest organs of K.Sh. patient after upper lobectomy of the right lung.*

To eliminate the residual cavity, a month later after the first surgery, there was performed - VATS extra pleural posterior superior 4 costal thoracoplasty on the right (Figure 7).

Figure 7: *Macropreparation and general view of the patient K.Sh. after VATS extrapleural posterior superior 4 costal thoracoplasty on the right.*

Observing chest x-ray in postoperative period there is an effective collapse of the right lung with the elimination of the residual cavity (Figure 8).

Figure 8: *Survey radiography of the patientK.Sh. after VATS surgery of extrapleural posterior superior 4 costal thoracoplasty on the right.*

The postoperative period was uneventful, wound healing by primary intention. On the 14th day after surgery, the patient was discharged home in a satisfactory condition (ECOG 0-1), with a recommendation to continue taking anti-TB drugs according to the MDR MTB treatment program. The long-term 5-year follow-up period: the patient has no relapse, recovered and engaged in active governmental work in a public institution.

Nosocomial mortality was recorded in one patient (1.9%) on the 21st day after surgery; from massive bleeding from GIT against stress ulcers. 4 patients did not complete the stages of surgical treatment and continue conservative treatment programs. Long-term results were studied in 43 (81.1%) patients since 5 patients have been lost for the follow-up. 39 patients are alive and well, without relapse of pulmonary TB. In the long- term, 4 patients died from the progression of TB process.

Of the 91 patients, nosocomial mortality was recorded in 3 (3.3%), immediate good efficacy was noted in 82 (90.1%) patients, 13 (14.3%) died in the long- term period,5 (5.5%) patients continue treatment, another 5 (5.5%) patients were lost for the follow-up, in 65 (71.4%) patients - recovery without relapses.

Conclusion

Active surgical tactics for postoperative bronchopleural complications has been justified and should be selected individually. The effectiveness of the new methods we use, such as transsternal, transmedistinal occlusion of MB without opening the pericardial cavity with plastic surgery of the bronchial stump by remnants of the thymus tissue and VATS extra pleural thoracoplasty, has been proven and highly appreciated. Drug resistance of MBT, bilateral destructive pulmonary TB, chronic viral hepatitis (B and C), and diabetes mellitus significantly increase the risk of postoperative bronchopleurothoracic complications and worsen the immediate and long-term results of surgical treatment of these complications. Patients with multidrug-resistant and extensively drug-resistant TB require closer attention in relation to preoperative preparation, determination of drug resistance of mycobacteria in sputum before surgery and after surgery from surgical material, timely adequate treatment strictly in accordance with DST data, since there is a risk of resistance amplification in the course of treatment.

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