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## The significance of reconstructive tracheal and bronchial surgery in the context of malignant pulmonary tumours

Lung cancer holds a prominent position in the malignant mortality rates. Despite the rapid advancement of pharmacological approaches to the lung malignancy treatment, surgical interventions remain relevant and pertinent in contemporary practice. The choice of an appropriate therapy for local lung cancer presents a particularly acute dilemma. This issue gives rise to contradictions as it necessitates a tailored approach for each individual case. In such instances, the only radical treatment methods for lung cancer involve surgical interventions, namely pneumonectomy and lobectomy/bilobectomy. The preference leans towards lobectomy, given that this choice mitigates disability, thereby enhancing the patient's quality of life. Organ-preserving surgery holds a distinct significance for patients with compromised functional reserves, where complete lung resection is intolerable. However, at the time of identifying centrally located lung neoplasms, tumors or metastatic lymph nodes often extend to the orifices of the segmental and main bronchi. A lobectomy is feasible only with the resection (wedge-shaped or circumferential one) of the main bronchus and subsequent bronchoplasty. Tumor invasion of the pulmonary artery presents a formidable obstacle to organ-preserving surgery.

In cases where pneumonectomy is intolerable, bronchoangioplastic lobectomy/bilobectomy stands as the sole viable radical intervention. Pneumonectomy with wedge-shaped or circumferential resection of the trachea, followed by tracheobronchoplasty, represents one of the most intricate procedures in thoracic surgery. However, when the tumor extends to the tracheal bifurcation, only this operation allows for a radical surgical approach. Notably, in circumstances where the tumor (carcinoid) affects the main bronchus, partial circumferential bronchial resection with subsequent bronchoplasty becomes feasible. Thus, the entire pulmonary ventilation capacity is preserved. Clinical observations of such procedures have been documented in patients with diminished functional reserves.

### Keywords

Lung cancer, tracheobronchoplastic surgery, organ-preserving interventions, local cancer, lymphadenopathy.

Respiratory tract malignancies remain a significant global concern, of which, according to contemporary literature, in 2018, more than 2 million new cases were diagnosed. Unfortunately, 1.8 million individuals died from this pathology [5]. Lung cancer (LC) is characterized by rapid growth and metastasis. According to the cancer registry data in Ukraine for 2020, cancer of the trachea, bronchi, and lungs was identified in 8,222 men and 2,129 women [1]. In 2022, the incidence of malig-

nant lung neoplasms in Ukraine was 40.5 per 100,000 population [6]. The World Health Organization (WHO) reports that about 10 million people worldwide die annually from oncological diseases. Malignant diseases claim the lives of every sixth inhabitant of the planet [2]. LC holds the first place in oncological mortality. Despite the variety of modern diagnostic methods, this pathology is typically diagnosed at advanced stages (III–IV). The authors claim that only 20–25 % of patients diag-

nosed with non-small cell LC are potentially operable. However, recurrence of the disease is diagnosed in 30–55 % of patients who undergo surgical treatment, and ultimately, patients die from LC [3]. Patients with local LC require a specialized approach to treatment. Since surgical intervention is the only radical treatment method today, each potentially operable case must be considered in a multidisciplinary manner, especially in cases where the patient has limited functional capacities. In this paper, clinical cases of patients who underwent radical tracheobronchoplastic surgery are presented.

### Clinical case 1

A 75-year-old *patient P.*, was admitted on January 17, 2016, presenting complaints of hemoptysis, persistent dry cough, and dyspnea at physical activity. Fibrobronchoscopy revealed the presence of a tumor in the upper lobe bronchus of the left lung, along with the bronchial passage obturation. A chest Computer tomography (CT) with contrast (Fig. 1) showed a new malformation in the upper left lung. This growth extended towards the upper lobe bronchus and was closely situated near a branch of the left pulmonary artery, potentially showing signs of invasive characteristics.

According to the medical history, two decades ago the patient underwent an upper right lobectomy to address a tumor situated in the upper region of the right lung. This prior surgical intervention renders the option of performing a left-sided pneumonectomy (necessary due to the current tumor's location) unviable, as the upper lobe on the right side is absent. As a result, the proposed course of action involved a left-sided thoracotomy, accompanied by an intraoperative assessment, with possibility of a reconstructive, organ-preserving procedure (Fig. 2).

A left lateral thoracotomy was performed. Upon revision, it was observed that the tumor was localized at the root of the upper portion, and did not extend into the structures of the lower portion. After separating the interlobar fissure, ligating and transecting the arteries of the anterior and posterior-apical segments of the upper portion, an invasion was found at the artery's orifice in the lingular segments of the upper portion. The upper pulmonary vein was ligated and divided manually. Subsequently, a circumferential resection of the left main bronchus and the lower lobar bronchus was performed at its division into the bronchus of the sixth segment and the stem of the basal segments. This allowed for a peripheral instrumental resection of the pulmonary artery within the tumor invasion zone, while preserving the unchanged vessel wall (macroscopically) (Fig. 3).

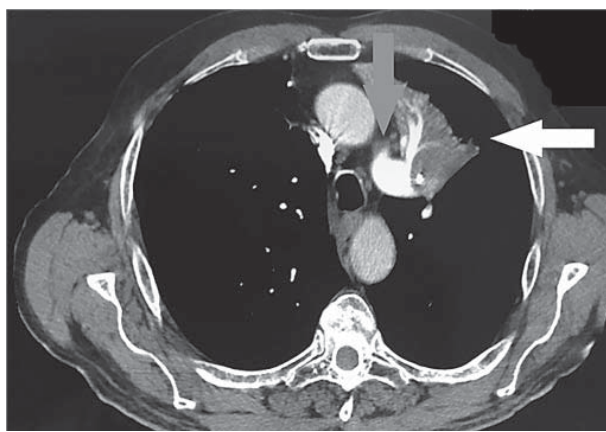


Fig. 1. CT of patient P. The white arrow indicates the tumor in the upper left lung, while the gray arrow indicates the left pulmonary artery

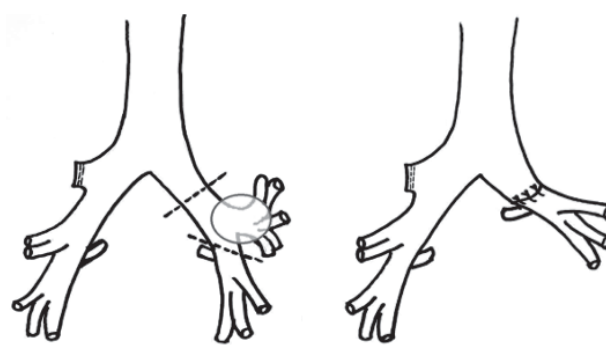


Fig. 2. Scheme of the operation

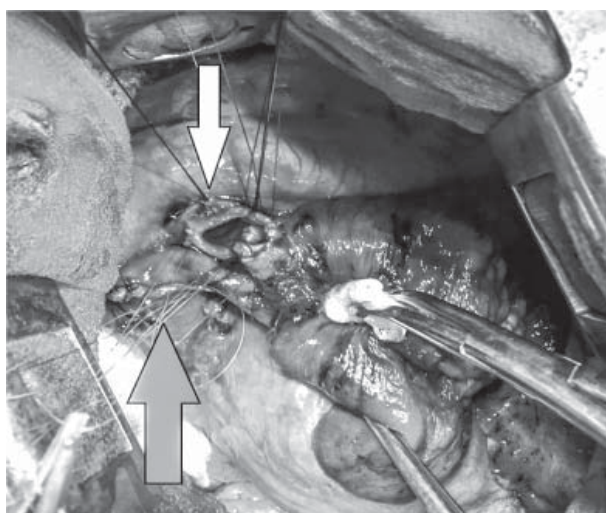


Fig. 3. Intraoperative photo: the area of pulmonary artery resection is indicated by the gray arrow, and the initial stage of forming an anastomosis between the left main bronchus and the segmental bronchi is indicated by the white arrow

After completing the anastomosis, the latter was checked for tightness and the ventilation of the lower part of the left lung was restored (Fig. 4).

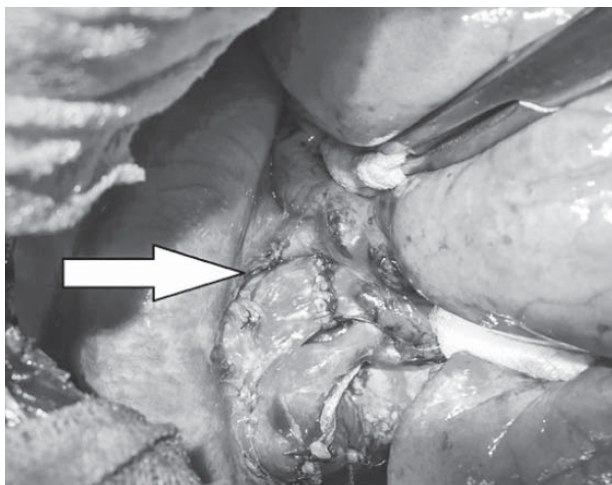


Fig. 4. Intraoperative photo: the white arrow indicates the final appearance of the formed anastomosis



Fig. 5. Chest X-ray of patient K. before discharge

P??

The postoperative period was without complications. Histological conclusion: squamous cell lung carcinoma pT2pN1M0, G2. The resection margins of the bronchial tree and pulmonary artery are clear. On the 22<sup>nd</sup> day after the surgery, the patient was discharged in satisfactory condition. Chest X-ray before discharge (Fig. 5).

#### Clinical case 2

A 30-year-old *patient T.*, referred to the clinic of Bogomolets National Medical University, Department of Oncology, based at Kyiv Clinical Hospital No. 3, in September 2016. She complained of a cough and dyspnea during moderate physical exertion. Prior to her visit, she had undergone chest CT and FBS (Fig. 6) at one of the medical facilities in Kyiv. A malignant tumor (carcinoid) of the right main bronchus was diagnosed, and a right-sided pneumonectomy was suggested. The patient refused the proposed treatment.

We proposed an organ-preserving surgical option (Fig. 7).

On September 19, 2016, a right-sided lateral thoracotomy was performed. A circumferential resection of the right main bronchus was performed, leaving one-half of a bronchial ring from the carina (proximal margin) and in the region of the division of the right main bronchus into the upper lobar and intermediate bronchi (distal margin) (Fig. 8 and 9).

After the circumferential resection of the right main bronchus, an anastomosis was created between the tracheal bifurcation and the upper lobar and intermediate bronchi (Fig. 10).

As for the specifics: the tumor (Fig. 11) did not extend beyond the boundaries of the right main bronchus, regional lymph nodes, and there was a significant amount of mucopurulent sputum in the right lung (sanitation during the operation).

Postoperative period proceeded without complications. Histological conclusion: atypical carcinoid of the right main bronchus, bronchial margins are ablative, no metastases in regional lymph nodes detected. The patient regularly undergoes follow-up



Fig. 6. CT scans of the chest of patient T.

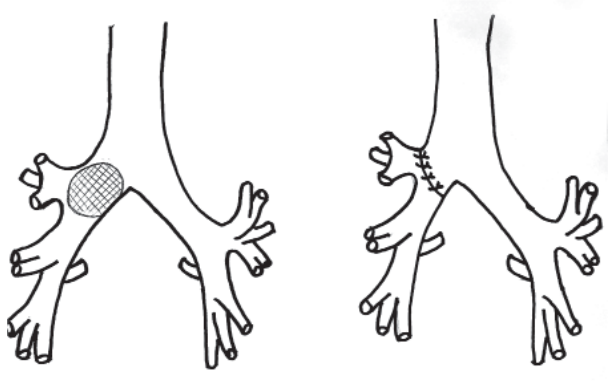


Fig. 7. Proposed surgical procedure scheme for patient T.

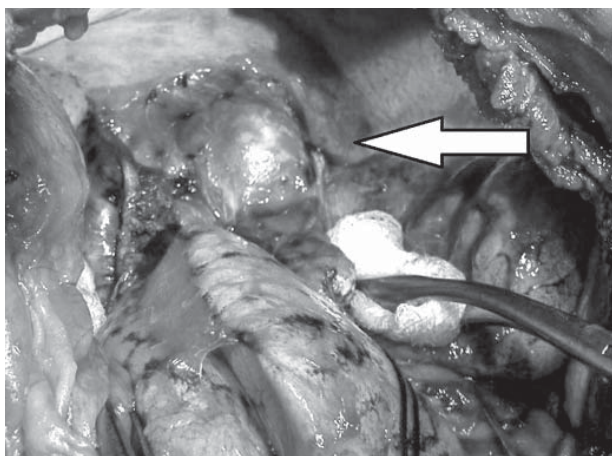


Fig. 8. Intraoperative photo: the white arrow indicates the carcinoid tumor of the right main bronchus

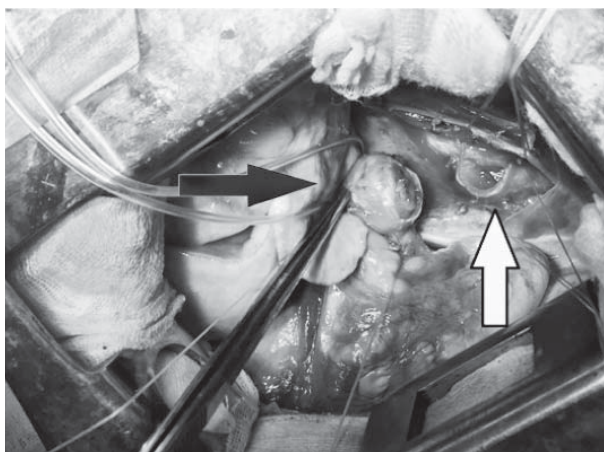


Fig. 9. Intraoperative photo: the white arrow indicates the transected right main bronchus, the gray arrow indicates the tumor within the lumen of the resected right main bronchus



Fig. 10. Intraoperative photo: the stage of forming an anastomosis between the tracheal bifurcation and the upper lobar, intermediate bronchi



Fig. 11. Macroscopic specimen, tumor of the right main bronchus

examinations (chest X-ray, fibrobronchoscopy), and there is no evidence of disease recurrence.

### Clinical case 3

A 65-year-old *patient, Mr. S.*, was admitted on January 9, 2018, to the clinic of the Bogomolets National Medical University, Department of Oncology, at Kyiv Clinical Hospital No. 3. The patient complained of cough and shortness of breath during moderate physical exertion. CT of the chest revealed signs of central endobronchial cancer of the upper lobe of the right lung with invasion into the right main bronchus (Fig. 12).

We offered the patient was offered surgical intervention for the right lung resection, and a wedge resection of the tracheal bifurcation (Fig. 13).

On January 15, 2018, the patient underwent a right posterior-lateral thoracotomy. A pneumonec-

tomy with a wedge resection of the tracheal bifurcation was performed (Fig. 14).

After mobilizing the tracheal bifurcation, a through-the-pleura breathing shunt was used (Fig. 15).

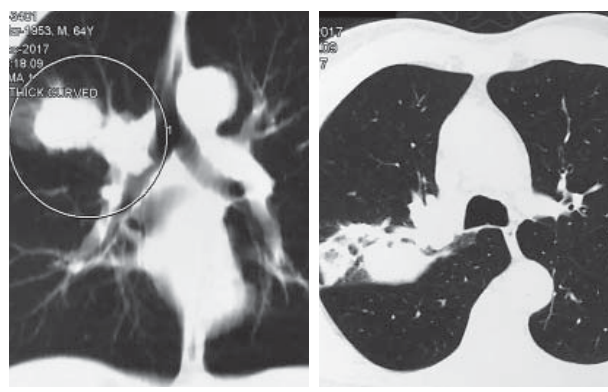


Fig. 12. Chest CT scan of patient S.

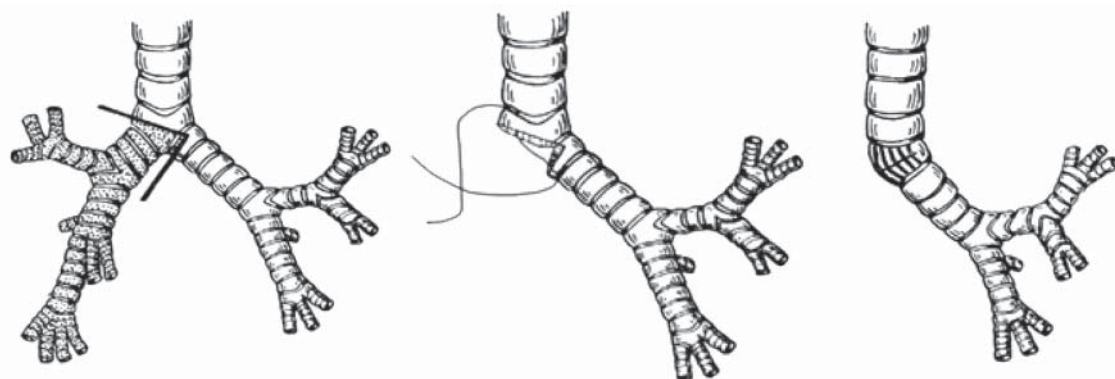


Fig. 13. Proposed treatment plan for patient S.

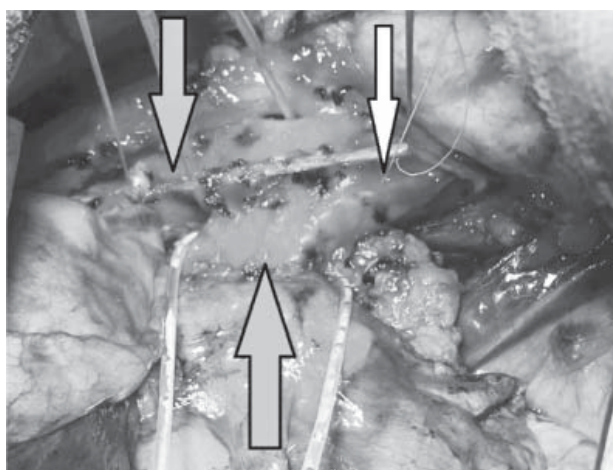


Fig. 14. Intraoperative photo: tracheal bifurcation dissected — white arrow, right and left main bronchi — gray arrows

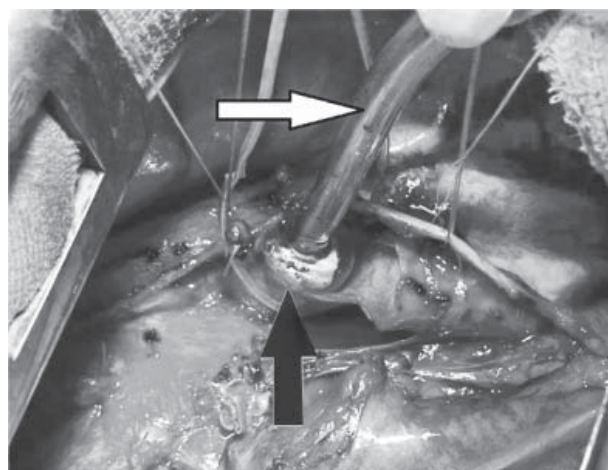


Fig. 15. Intraoperative photo: tracheal bifurcation dissected. The white arrow indicates the through-the-pleura shunt used to provide ventilation to the left lung. The black arrow points to the left main bronchus

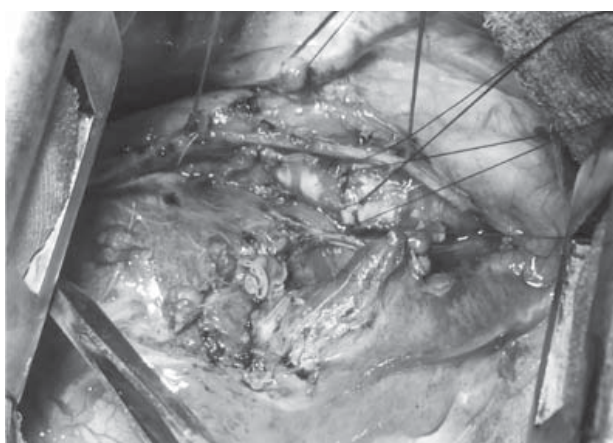


Fig. 16. Intraoperative photo: final appearance of the formed anastomosis

Tracheobronchial tree integrity was restored by a «three-quarters» anastomosis between the left main bronchus and the trachea. (Fig. 16).

The postoperative period proceeded without complications. Patient S. was discharged on the 11<sup>th</sup> day.

### Conclusions

The presented clinical observations vividly demonstrate the necessity for an individual approach to the surgical treatment of oncological pathology. This is particularly crucial in lung surgeries, given its direct impact on preserving the patient's respiratory function, as evidenced in the case of the young female patient. The proposed pneumonectomy, while potentially radical from an oncological standpoint, would have considerably compromised the respiratory function, limited physical activity, and diminished the quality of life for a 30-year-old patient, with a risk of cardiac failure. Conversely, in the case of the patient described in the first clinical observation, the surgical procedure adopted proved to be oncologically radical, facilitating the retention of a healthy lower portion of the left lung and an improved quality of life. Importantly, this approach successfully averted the need for palliative chemoradiotherapy, mirroring the course of action taken with patient S.

There is no conflict of interest.

Participation of authors: Participation of the authors: authors have equal shares of participation in the article.

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## Роль реконструктивної хірургії трахеї та бронхів при злоякісних пухлинах легень

Рак легень посідає провідне місце в смертності від злоякісних захворювань. Незважаючи на стрімкий розвиток медикаментозних методів лікування онкологічних уражень легень, хірургічні підходи досі застосовують. Актуальним є питання щодо вибору методу лікування місцево поширеного раку легень, оскільки потрібен індивідуальний підхід. Єдині радикальні методи лікування — хірургічні втручання з приводу раку легень (пневмонектомія та лобектомія/білобектомія). Перевагу віддають лобектомії, оскільки це зменшує інвалідизацію, а отже, поліпшує якість життя хворого. У пацієнтів із низькими функціональними резервами, коли видалення цілої легені небажане, виконують органощадні операції. Однак на момент виявлення центрально розташованого новоутворення легені пухлина або метастатичні лімфовузли часто поширюються на устя часткового й головного бронха. Виконання лобектомії можливе лише з резекцією (клиноподібною або циркулярною) головного бронха та бронхопластиком. Інвазія пухлиною легеневої артерії — серйозна перешкода для органощадної операції. За неможливості виконання пневмонектомії бронхоангіопластична лобектомія/білобектомія — єдине можливе радикальне втручання. Пневмонектомія з клиноподібною або циркулярною резекцією трахеї та трахеобронхопластиком належить до найскладніших операцій у торакальній хірургії. Однак якщо пухлина поширюється на біфуркацію трахеї, то лише ця операція дасть змогу виконати радикальне втручання. Якщо пухлина (карциноїд) уражає головний бронх, то можливе виконання парціальної циркулярної резекції бронха з подальшою бронхопластиком. Це дає змогу зберегти весь дихальний об'єм легені. Наведено клінічні спостереження таких операцій у хворих із низькими функціональними резервами.

**Ключові слова:** рак легень, трахеобронхопластичні операції, органощадні втручання, місцево поширений рак, лімфоаденопатія.

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