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Single lung resection: The limits of the possible. Clinical report

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ABSTRACT

INTRODUCTION: Single lung resection remains a challenge due to the preservation of the respiratory reserve. This report presents that case of a female patient with bilateral fibrotic-cavitary pulmonary tuberculosis complicated with empyema on the right lung. Only 3.5 lung segments were left after a multistage surgery.

PRESENTATION OF CASE: The first stage included draining of empyema and transsternal transmediastinal right main bronchus occlusion. Then, upper lobectomy with partial S6 resection of the left lung, followed by pleuropneumectomy was performed. At a follow-up of two years and 10 months, patient's condition was good.

DISCUSSION: Although single lung surgery has been possible over half a century ago, it remains a high-risk intervention.

CONCLUSION: With the removal of the non-functioning parenchyma and elimination of the air/vascular shunt, single lung resection volume exceeding lobectomy is possible, which may improve cardiorespiratory function.

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1. Introduction

The challenges in single lung resections are closely related to the question of the minimum respiratory volume required for living. It was supposed that the volume of resection should not exceed three segments [1].

The low treatment efficacy of extensive drug-resistant (XDR) tuberculosis (TB) worldwide (34%) [2] is one of the main obstacles of effective TB control.

This case is unique due to the unprecedented extended volume of bilateral lung resection in a patient with XDR pulmonary TB. Following resection, only 3.5 of the 18 pulmonary segments were left, but favorable outcomes were achieved. This case report is compliant with the SCARE Guidelines [3].

2. Clinical observation

A 45-years-old woman complained of coughing with purulent sputum up to 500 ml per day, dyspnea at rest, fever up to 38 °C, sweating, weakness, lack of appetite, and weight loss, and she was

admitted in Sechenov University Clinic for Phthisiopulmonology in 2015. She had contact with a neighbor regarding TB.

In 2002, destructive TB with right lung seeding and smear-positive findings were detected by a local hospital physician after the patient complained of cough and hyperthermia. Antituberculars were administered. However, during treatment, the undulating progression accompanied with formation of the fibrotic cavities in the right lung and left upper lobe was observed, and then total empyema occurred on the right with bronchopleural fistula. In 2008, after mycobacterial TB (MTB) drug resistance was determined, different treatment regimens were prescribed. The patient received TB therapy until 2015 but with low adherence. The patient was consulted several times by thoracic surgeons in various institutions. Surgical treatment was considered to be contraindicated due to disease progression and low respiratory reserves.

The patient was brought to our clinic in severe condition. On examination, she had pale skin, was underweight (body mass index [BMI] of 16.6 kg/m²), and had dyspnea at rest (respiratory rate of 27 per minute). During chest percussion, on the right tympanic sound was heard in all fields of the right lung up to the VII rib level, but only until the subclavian region in the left lung. On auscultation, no breath sounds were heard on the right lung, and amphoric breathing with rales in the upper sections were heard on the left lung.

Computed tomography (CT) revealed complete collapse of the right lung and total pleural empyema with a liquid level. On the

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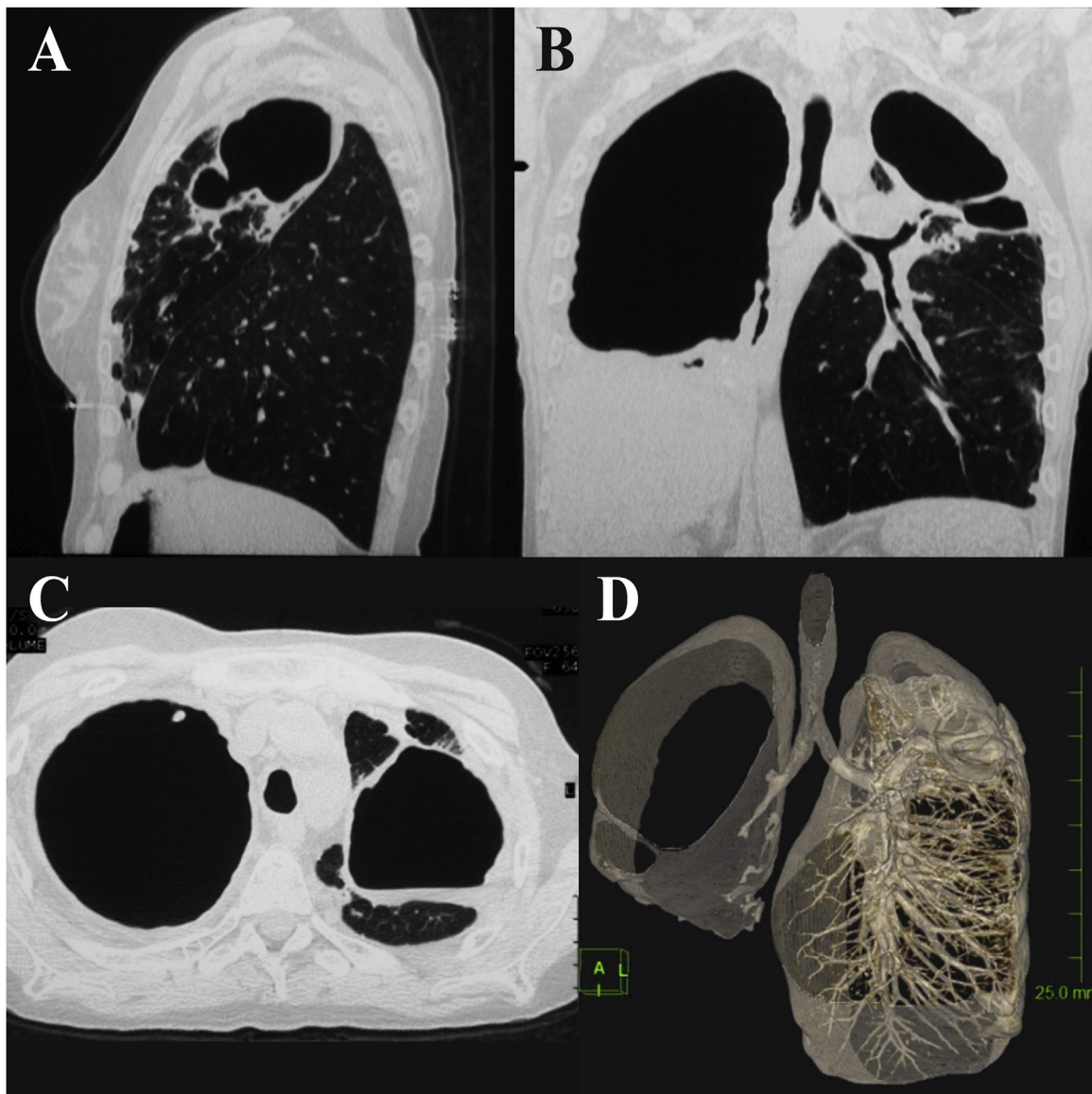


Fig. 1. CT Scan on admission in sagittal (A), frontal (B) and axial (C) projections and 3D reconstruction (D).

left lung, a giant fibrotic cavity of up to 15 cm in diameter with a liquid level occupied almost the entire upper lobe (Fig. 1A–D). It was surrounded by foci of various sizes.

Values of spirometric parameters vital capacity (VC) and forced expiratory volume in 1 s (FEV1) were 1.41 L(41%) and 0.74 L(25%), respectively. The partial pressures of blood gases were 63 mmHg and 44 mmHg for pO₂ and pCO₂, respectively. The 6-minute walking test (6MWT) distance was 270 m. Fibrobronchoscopy revealed bilateral purulent endobronchitis. Blood tests showed leukocytosis $11.7 \times 10^{12}/L$, erythrocyte sedimentation rate (ESR) of –54 mm/h, ALT 132Units/L. Acid-fast bacilli were found in the sputum. MTB presence and XDR were confirmed by culture methods.

Considering the aforementioned findings, the patient was diagnosed with smear-positive bilateral fibrotic-cavitary pulmonary XDR TB complicated with total chronic pleural empyema on the right lung, cachexia, chronic bronchitis and respiratory failure was diagnosed without difficulties. Moreover, the patient had chronic viral hepatitis C.

The prognosis without surgical treatment was extremely poor. Patients with destructive TB of a similar prevalence in the presence of XDR die within 1–3 years. Considering the vital indications

and the patient's attitude, the consensus of surgeons, phthisis pulmonologists, and anesthesiologists decided to perform a multi-stage surgery.

The first stage was carried out in September 2015. It included draining of the empyema cavity on the right lung and transsternal transmediastinal right main bronchus occlusion (Giller D.B.). The operation time was 125 min, and blood loss was 50 ml.

Histological examination of the removed main bronchus specimen of the revealed active bronchial TB. Local draining of the empyema cavity was continued in the postoperative period. The patient's condition improved significantly, dyspnea decreased, the sputum amount did not exceed 50 ml per day, and body temperature returned to normal. At 2 months after the first stage of surgery, despite the decrease in VC and FEV1, exercise tolerance increased significantly. VC and FEV1 values were 1.14 L (33%) and 0.74 L (22%), respectively; pO₂ and pCO₂ were 72 mmHg and 44 mmHg, respectively; and the 6MWT distance was 440 m.

In November 2015, the second stage of surgical treatment was carried out. Upper lobectomy with partial S6 resection was performed on the left lung (Giller D.B.) (Fig. 2A). The operation time was 260 min, and the blood loss was 600 ml. The lung was exposed

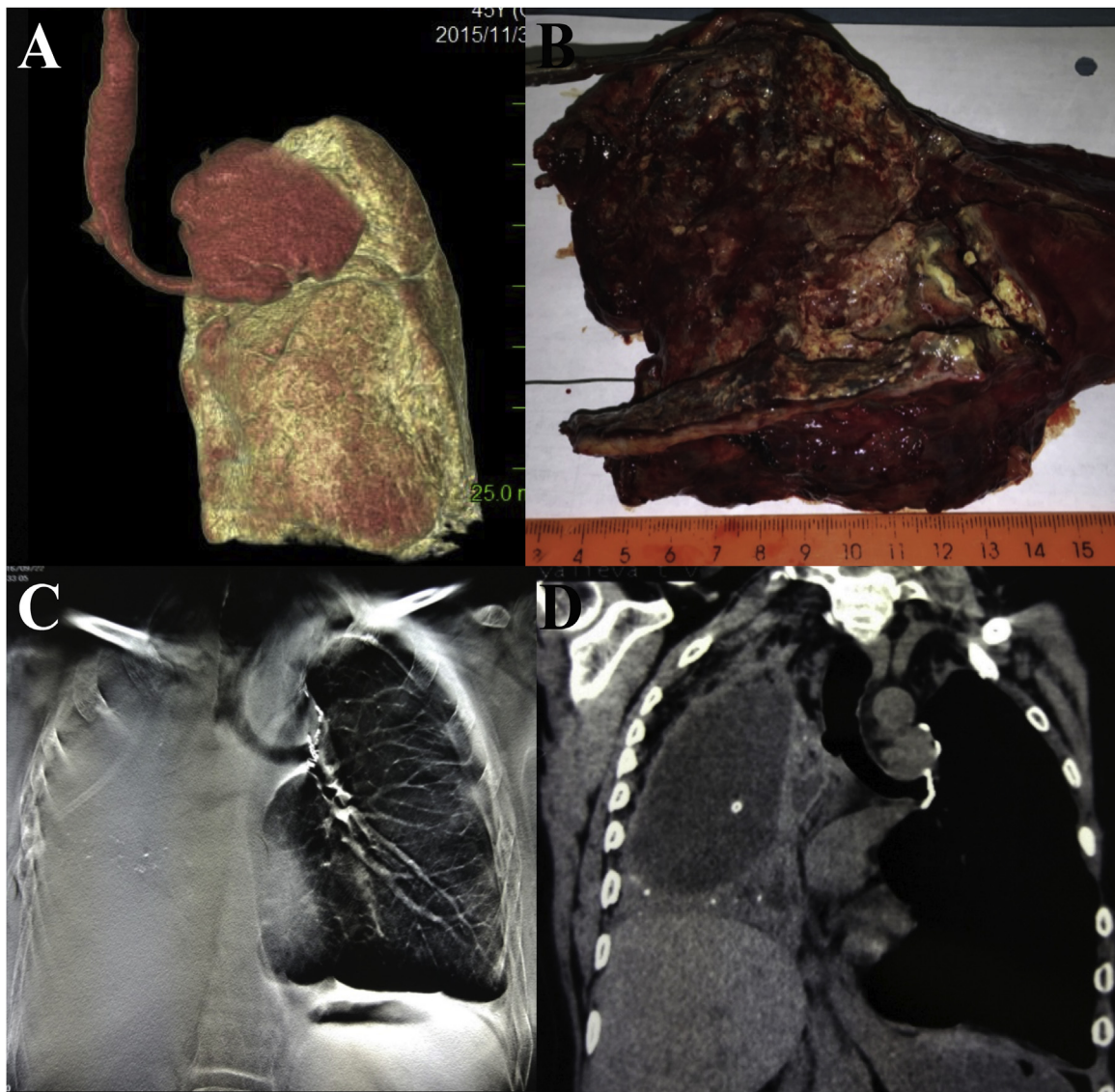


Fig. 2. A - 3D-reconstruction after upper lobectomy with partial S6 resection on the left. B - gross section. C - Tomosynthesis and D - CT scan in frontal projection after the second stage.

to the hilum from a total dense, bleeding adhesions. The interlobar fissure was roughly consolidated. The cavern penetrated the upper lobe in the S6 projection. The upper lobe vessels were exposed, ligated, and intersected separately. The upper lobe bronchus was stapled and additionally manually sutured with atraumatic sutures. A giant cavern was found in the resected specimen (Fig. 2B). Histological study verified fibrotic-cavitary TB and upper lobe bronchus TB. Delayed lung expansion occurred in the postoperative period (Fig. 2C).

After 1 year, CT scan showed a completely expanded lung (Fig. 2A, D). The disabled right lung was collapsed, and the empyema cavity was filled. Functional condition improved. As a result, VC and FEV1 values were 1.42 L(41 %) and 0.98 L(33 %), respectively. The partial pressures of blood gases were pO₂-67 mmHg and pCO₂-43 mmHg, and the 6MWT distance was 425 m.

The third stage of surgery was performed during the Moscow International Conference of Thoracic Surgeons. Pleuropneumonec- tomy was performed on the right lung (Giller D.B., Rückert J.C.). The

operation time was 180 min, and the blood loss volume was 550 ml.

The resected specimen included the destroyed right lung and empyema cavity (Fig. 3A). Histologically, TB was confirmed. The postoperative period was uneventful, and TB chemotherapy was continued. The patient was discharged in satisfactory condition with a completely filled postpneumonectomy cavity (Fig. 3B).

At follow-up two years and 10 months after the surgery, the patient's condition was good. She gained 19 kg of body weight (BMI of 23.2 kg/m²), and she had not experienced productive cough. CT did not detect signs of TB reactivation (Fig. 3C, D). MTB was not detected in the sputum in every examination following the second stage. Spirometry parameters VC and FEV1 amounted to 1.37 L(40 %) and 0.95 L(32 %), respectively. The partial pressures of blood gases were pO₂-77 mmHg and pCO₂-39 mmHg, and the 6MWT distance was 420 m. The patient easily did the work at home, went shopping, went to the 3rd floor without stops. The patient was pleased of the treatment outcomes.

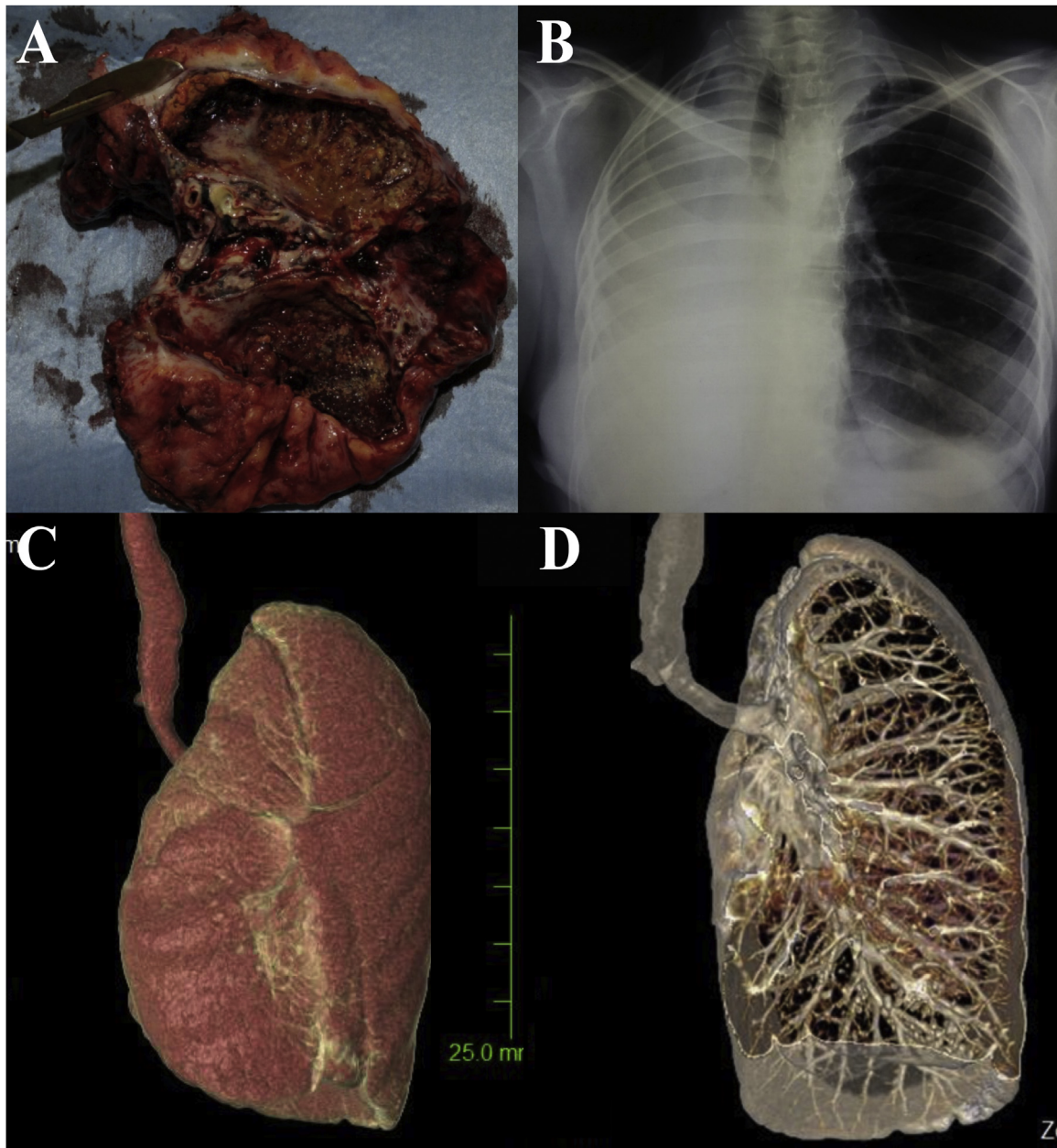


Fig. 3. A – Gross section of destroyed right lung and empyema cavity together. B – Plain chest film after surgery. C,D – CT 3D-reconstructions a year after surgery.

3. Discussion

The first single-lung surgical treatment was applied in 1948 by Waterman D. [4], who performed a S10 resection for metastasis in a 52-year-old patient.

However, even if single-lung surgical treatment was possible over half-century ago, it remains the most high-risk and rarely performed intervention in lung surgery.

In a review by Toufektzian L. in 2014 [5], who investigated the safety and the feasibility of a single-lung resection, 102 patients underwent 96 segmental resections and six lobectomies in a single lung with an average postoperative mortality of 6.2 % and 33.3 %, respectively.

In 2014, we also published data on single-lung resection [6], of which 90 of 160 patients had TB. There were 30 single-lung lobectomies, including 24 upper lobectomies on the right lung, two middle lobectomies on the right lung, two upper lobectomies on the

right lung with S6 resection, one lower lobectomy on the right lung and one lower lobectomy on the left lung.

In 1997, Spaggiari et al. [7] described the most extensive single-lung resection, i.e., lower lobectomy on the right lung. Five pulmonary segments in patient were retained. The surgery was performed for osteosarcoma metastasis in a 37-year-old woman, and the patient lived 10 years after a single lung resection.

In the present case, only 3.5 segments remained. Total removal of destroyed and non-functioning pulmonary parenchyma predetermined the possibility of an extensive resection in a patient with extremely low respiratory reserves. Removal of the non-functioning part of the lung eliminates the source of the sputum and the air/vascular shunt, which was reflected in the patient's increased exercise tolerance.

Thus, the volume of a single lung resection exceeding that in a lobectomy is possible, with the functional futility of the removed lung part, which may improve cardiorespiratory function.

Declaration of Competing Interest

The authors report no declarations of interest.

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None.

Ethical approval

Sechenov University Local Ethics Committee – approved №10-19/19.07.2019.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

Dmitry B Giller: Project administration; Conceptualization; Validation; Writing - review & editing.

Jens C Rückert: Supervision; Validation; Roles/Writing - original draft; Writing - review & editing.

Boris B Giller: Investigation; Software; Supervision; Visualization; Roles/Writing - original draft.

Oleg Sh. Kesaev: Data curation; Formal analysis; Investigation; Methodology; Validation; Roles/Writing - original draft.

Yakub G. Imagozhev: Data curation; Formal analysis; Investigation; Methodology; Validation; Roles/Writing - original draft.

Galina V. Scherbakova: Formal analysis; Investigation; Methodology; Project administration; Validation; Visualization; Roles/Writing - original draft.

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