

1. Introduction

The connection between changes in the density of the lung parenchyma with the course of lung disease is already well known. The results of computed tomography (CT) with densitometric analysis and clinical markers in patients with chronic obstructive pulmonary disease have a stable reliable relationship [1]. Studies, in particular CT densitometry, allow a direct quantitative assessment of emphysematous changes in the lung. This method is confirmed both clinically and pathohistologically [2, 3].

Changes in the parenchyma CT densitometry detects earlier than the deviations of spirometric parameters [4]. The researchers point out that pathological examinations reveal up to a third of the pulmonary tissue destroyed by emphysema before spirometric abnormalities are identified. CT densitometry can be an important technique for early detection of diseases that are of increasing clinical interest. The dependence of spirometric parameters on lung density indicators (i. e., densitometrically it is possible to determine and assume lung dysfunction OFV₁, etc.), which is especially important in the era of COVID-pandemic.

The use of non-invasive interventions and physical reduction of contact with patients is becoming extremely relevant today [5].

In phthiology, studies of lung density as a manifestation of genetic preconditions and individual molecular code (such as the rationale for targeted therapy in oncology) are currently can not be found in open literature.

Some works of domestic (including the authors of the article) and foreign experts in determining the impact of CT densitometry on the course of lung diseases are noted. The connection of densitometry indicators with the activity of the tuberculosis process has been established [6–8]. A correlation was found between CT scan and bacterial excretion in tuberculosis [9]

Given that CT scan is essentially a computer-reproduced reality, reconstructed in space in the form of pixels, the information is primarily in the digital dimension. It is digital capabilities that allow us to measure the density, area and distance when analyzing the condition of the lung parenchyma and the affected areas, to make a quantitative assessment based on objective

FORECASTING THE BURDENED COURSE OF SURGERIES AND EARLY POSTOPERATIVE PERIOD IN PATIENTS WITH PULMONARY TUBERCULOSIS ON THE BASIS OF DENSITOMETRIC ANALYSIS OF PREOPERATIVE COMPUTER TOMOGRAPHY OF CHEST ORGANS

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Abstract: Topicality: the success of the use of densitometry in computed tomography of the lungs to assess the condition of the lungs prompted to determine the possibility of predicting the course of the disease in the surgical treatment of patients with pulmonary tuberculosis.

The aim: to determine densitometric criteria for prognosis of burdened intra- and postoperative course in patients operated on for pulmonary tuberculosis.

Methods: the analysis of preoperative densitometry indices in CT of the lungs in the upper and lower pulmonary fields on the side of the operation in 40 patients operated on for chemoresistant pulmonary tuberculosis with a burdened intra- and postoperative period and the effect of densitometric abnormalities on intra-operative period.

Results: in all examined patients the deviation of values of densitometry from conditional norm was revealed. In most patients with high parenchymal density there was obliteration of the pleural cavity and between the lobular fissures, fibrous changes in the root of the lung, with low density in most cases there was bleeding and insufficient tightness of the parenchymal suture, which together aggravates the early postoperative period.

Conclusions: the relationship between deviations in the density of the lung parenchyma before surgery and the possibility of aggravating factors in the process of surgical treatment of patients with pulmonary tuberculosis was discovered; it was determined that predicting the occurrence of certain aggravating factors in the process of surgical treatment of patients with pulmonary tuberculosis can help prevent complications of the operation or significantly reduce their manifestations.

Keywords: lungs, tuberculosis, treatment, surgery, computed tomography, densitometry.

indicators, rather than subjective opinion. To achieve these objectives, specialized programs are created [10] and work is underway to involve neural networks for the analysis of tomograms.

Based on the above, we suggested that the conditions of surgery for pulmonary tuberculosis may differ depending on the densitometric parameters of the lung parenchyma on which surgery is planned.

The aim. To determine densitometric criteria for prognosis of burdened intra- and postoperative course in patients operated on pulmonary tuberculosis.

2. Materials and methods

We examined 40 patients with a complicated course of intra- and postoperative course of chemoresistant pulmonary tuberculosis in the amount from segmentectomy to combined resection (lobectomy+segment resection). The lung parenchyma was sutured with a mechanical suture using a reusable stapler UO-60. Conditions that complicated and increased the duration of the operation, prolonged the length of stay of patients in the surgical department after the operation and encouraged the use of additional therapeutic actions were considered as an unfavourable course.

Patients were treated at the State Institution "National Institute of Tuberculosis and Pulmonology named after F. G. Yanovsky of National Academy of Medical Sciences of Ukraine". Computed tomography was performed on a CT scanner Aquilion TSX-101A manufactured by Toshiba (Japan) with recording the results of the study on digital media.

The research was conducted during 2019–2020. The research was approved by the Committee on Medical Ethics of the State Institution "National Institute of Tuberculosis and Pulmonology named after F. G. Yanovsky of National Academy of Medical Sciences of Ukraine", protocol No. 8 from 15.06.2018, study participants signed informed consent of the relevant content.

For data processing, a K-Pacs workstation was used, which was used to measure the density of lung tissue lesions in a selected area of the axial CT section.

In all these patients, preoperative densitometry in the upper and lower pulmonary fields on the side of the operation was selected by measuring the density by ROI (region of inter-

est) without including bronchi and vessels from segmental level and more, as well as pathologically altered tissue. In each pulmonary field, three measurements were performed with a hardware calculation of the mean and its standard deviation, which allowed us to obtain results with adequate homogeneity. The data were compared using the Student's criterion after checking the normality of the distribution of measured indicators. Collection, storage and mathematical processing of research materials was carried out using licensed software products included in the Microsoft Office Professional 2007 package, license Russian Academic OPEN No Level No. 43437596.

3. Results

It was found that in all patients with an unfavourable course of the intra- and postoperative period, the densitometric parameters were different from the conditional norm. According to the deviations, patients were divided into two groups (Fig. 1).

Group 1 included patients with reduced lung parenchyma density (emphysematous type), group 2 consisted of patients with high parenchymal density (fibrous type).

Characteristics and quantitative indicators of burdened intraoperative course in patients operated on for pulmonary tuberculosis are presented in Table 1.

Table 1

Characteristics and quantitative indicators of burdened intraoperative course in patients operated on for pulmonary tuberculosis (n=40)

Unfavourable factor	Group 1 (n=19)		Group 2 (n=21)	
	abs.	%	abs.	%
Connections between pleural leaves	14	73.7	4	19.0
Fibrous changes of root	18	94.7	8	38.1
Obliteration of interlobular fissures	17	89.5	7	33.3
Insufficient tightness of the parenchymal suture	0	0.0	16	76.2
Bleeding of the parenchymal suture	2	10.5	9	42.9
Difficulties in suturing parenchymal tears	5	26.3	10	47.6

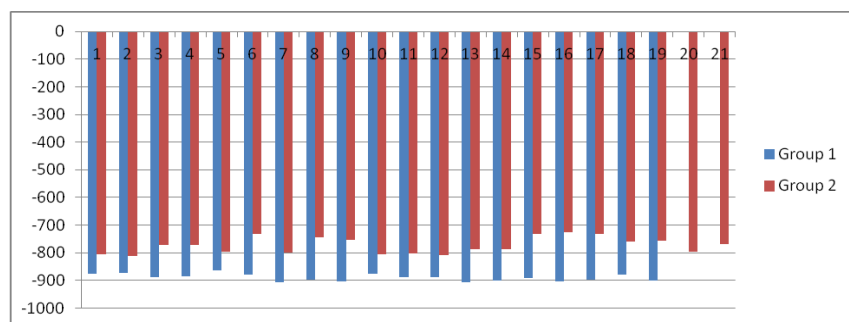


Fig. 1. Preoperative densitometry (Hounsfield scale) in the upper and lower pulmonary fields on the side of the operation in patients operated on for pulmonary tuberculosis (n=40)

As can be seen from Table 1, in the vast majority of patients in group 1 there was varying degrees of obliteration of the pleural cavity, which caused difficulty in pneumolysis, increasing the duration of surgery and surgical blood loss. Similarly, patients in group 1 had fibrous changes in the root of the lung and obliteration of the interlobular fissures, which also prolonged the duration of surgery, trauma, bleeding and the need for additional measures to achieve hemostasis and tightness. In patients of group 2 in almost 2/3 of cases there were defects of parenchyma stitching in the form of leaks, bleeding, which necessitated additional manual stitching of the mechanical suture with nodal sutures. In the cases of parenchymal tears in the process of pneumolysis and attempts to suture them, there were difficulties in achieving adequate tightness.

It should be noted that all differences in the selected criteria between the groups were statistically significant.

Characteristics and quantitative indicators of the burdened postoperative course in patients operated on for pulmonary tuberculosis are presented in Table 2.

As can be seen from Table 2, groups after surgery, according to the selected criteria, except for increased exudation, did not differ significantly. However, in a significant proportion of patients, both increased and decreased density of the lung parenchyma adversely affected the course of the early postoperative period.

Table 2

Characteristics and quantitative indicators of burdened postoperative course in patients operated on for pulmonary tuberculosis (n=40)

Unfavourable factor	Group 1 (n=19)		Group 2 (n=21)	
	abs.	%	abs.	%
Unstraightening of the lung for more than 3 days	3	15.8	5	23.8
Increased exudation	8	42.1	6	28.6
Prolonged air leakage (more than 5 days)	6	31.6	7	33.3

4. Discussion

The study of the relationship between the density of the lung parenchyma according to CT with the presence of certain pathological conditions is a current trend in modern medicine [1, 3, 4]. Using CT densitometry, the severity of pulmonary emphysema is assessed [2], differential diagnosis of pulmonary neoplasms is performed [5, 7], and the degree of activity of a specific process in pulmonary tuberculosis is determined [6, 8].

This study is limited to the contingent of patients with pulmonary tuberculosis who are shown surgical treatment within partial lung resections. By comparing the deviations of the density of the pulmonary parenchyma and the options of the burdened course of the intra- and postoperative period, certain patterns were identified. Of course, the complications under consideration were not critical. As a result, the application of additional treatment measures was able to achieve a satisfactory treatment result in all patients. However, the occurrence of aggravating factors after surgery, approximately one third of

patients caused the need for additional treatment, extended the length of stay of patients in a surgical hospital and, accordingly, increased its cost.

At the same time, having the opportunity to count on a significant probability of the occurrence of certain aggravating factors in the surgical treatment of patients with pulmonary tuberculosis, it is possible to take measures in advance to prevent complications or significantly reduce their manifestations.

In the future, it seems appropriate to use drugs of prevention of severe course in patients at risk of its occurrence according to densitometric data and evaluation of the results of the use of preventive measures.

5. Conclusions

1. The relationship between deviations in the density of the lung parenchyma before surgery and the possibility of aggravating factors in the surgical treatment of patients with pulmonary tuberculosis was established.

2. Predicting the occurrence of certain aggravating factors in the process of surgical treatment of patients with pulmonary tuberculosis can contribute to the early adoption of measures to prevent complications of the operation or significantly reduce their manifestations.

Conflict of interests

The authors declare no conflict of interests.

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Received date 15.09.2020

Accepted date 16.10.2020

Published date 29.10.2020

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