ROLE OF COMPUTER TOMOGRAPHY IN DIAGNOSTICS OF CORONAVIRAL ETIOLOGY OF PNEUMONIA

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Abstract
In December 2019, a major outbreak of a novel coronavirus infection occurred in Wuhan, Hubei province, China. The number of infected people at the beginning of 2021 exceeded 90 million people, the death rate was almost 2 million. Materials and Methods. Our study included 110 patients diagnosed with COVID-19 pneumonia, age range from 26 to 83 years (61 F: 49 M). The incubation period ranged from 2 to 21 days, on average 5-7 days. All patients underwent computed tomography of the lungs using Toshiba Aquilion 32 and GE revolution EVO 128 scanners. Tomography was performed in a routine mode at an X-ray tube voltage of 120 kV. Discussion. Based on the results of the analysis of the data obtained during the study in patients with SARS CoV-2 pneumonia, it was demonstrated that MSCT is a highly sensitive method for diagnosing pathological changes in the lung tissue. CT-semiotics of viral pneumonia COVID-19 described in the literature (numerous peripheral compactions of the lung tissue of the "ground glass" type, consolidation of lung tissue, reticular changes, thickening of the pleura, subpleural enlightenment (like air stripes), symptom of air bronchogram, thickening of the interlobular interstitium of the "cobblestone" type ("crazy-paving" sign), "halo", the opposite "halo" was clearly seen in our patients.
Keywords: COVID 19, CT scan, CT scan of severity, lung changes.

抽象的
2019年12月，中国湖北省武汉市发生新型冠状病毒感染的重大疫情。 2021年初感染人数超过9000万人，死亡率接近200万。材料和方法。我们的研究包括 110 名诊断为 COVID-19 肺炎的患者，年龄范围为 26 至 83 岁（61 F：49 M）。潜伏期为2至21天，平均5至7天。所有患者均使用 Toshiba Aquilion 32 和 GE 革命 EVO 128 扫描仪进行肺部计算机断层扫描。断层扫描以常规模式在 120 kV 的 X 射线管电压下进行。讨论。根据对 SARS CoV-2 肺炎患者研究期间获得的数据的分析结果，证明 MSCT 是诊断肺组织病理变化的高度敏感方法。文献中描述的病毒性肺炎 COVID-19 的 CT 符号学（"毛玻璃"型肺组织的大量外周压实、肺组织实变、网状改变、胸膜增厚、胸膜下启发（如空气条纹），空气支气管征，"鹅卵石"型（"疯狂铺路"征）小叶间质增厚，"晕"，在我们的患者中清楚地看到相反的"晕"。
关键词：COVID 19，CT 扫描，严重程度 CT 扫描，肺部变化。

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Introduction

In December 2019, a major outbreak of a novel coronavirus infection occurred in Wuhan, Hubei province, China. The number of infected people at the beginning of 2021 exceeded 90 million people, the death rate was almost 2 million [5, 7, 13]. During the COVID-19 pandemic, computed tomography (CT) of the chest was the leading method for assessing the volume of lung damage and follow-up [1, 8, 10]. Changes in the lungs are quite variable, but most authors agree that the most frequent changes are a decrease in airiness of the "ground glass" type, as well as a combination of these changes with consolidation and reticular changes [2, 6]. The use of CT is advisable for the primary assessment of the state of the chest organs in patients with severe progressive forms of the disease, as well as for the differential diagnosis of identified changes and assessment of the dynamics of the process [4, 9. 12]. Assessment of the severity of changes in the lungs during CT in patients with suspected COVID-19 pneumonia is an "empirical" visual scale based on a visual assessment of the approximate volume of compacted lung tissue according to Russian methodological recommendations, 5 degrees of severity are distinguished: from CT-1 (up to 25%) to CT-4 (more than 75%), highlighting CT-0 - with no lesion [3, 6, 11].

Purpose of the study. The aim of our study was to evaluate various CT patterns in patients with COVID-19 and compare the data from PCR tests.

Materials And Methods

Our study included 110 patients diagnosed with COVID-19 pneumonia, age range from 26 to 83 years (61 F: 49 M). The incubation period ranged from 2 to 21 days, on average 5-7 days. All patients underwent computed tomography of the lungs using Toshiba Aquilion 32 and GE revolution EVO 128 scanners. Tomography was performed in a routine mode at an X-ray tube voltage of 120 kV. The program was loaded with a series of CT images of the chest with a slice thickness of 1 mm. The presence and volume of signs were assessed: "frosted glass", consolidation, reticular changes, "cobblestone pavement"

Results

The patients were divided into four groups according to the temporary guidelines (Table 1).

Table 1. Disease severity in COVID-19 with CT signs

The degree of change	The degree of changes in CT signs
CT 0	The norm or absence of CT signs of viral pneumonia against the background of typical clinical manifestations and epidemiological history
CT 1	Areas of compaction of the lung tissue according to the type of "ground glass" Involvement of less than 25% of the lung volume
CT 2	Areas of compaction of lung tissue according to the type of "ground glass" Involvement of 25% to 50% of lung volume
CT 3	Areas of compaction of lung tissue by the type of "ground glass" Areas of consolidation Involvement of 50% to 75% of lung volume Increase of the

	lesion volume by 50% in 24-48 hours against the background of respiratory disorders during dynamic observation
CT 4	Diffuse lung tissue damage with reticular changes Involvement of more than 75% of the lung volume Hydrothorax

After assessing the prevalence of patterns, the extent of the lesion was analyzed. The distribution is shown in the diagram (Fig. 1).

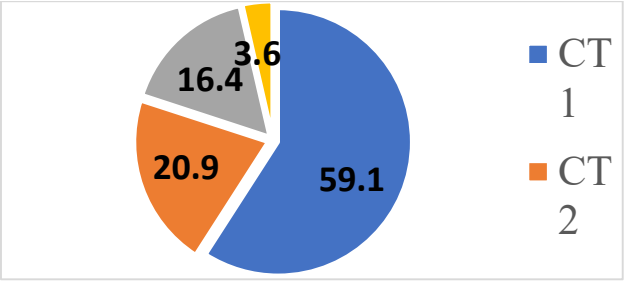


Figure 1. Structure of the study group by degrees (1-4) CT severity

There was also a comparison of PCR results with CT severity (Table 2).

Table 2. PCR results depending on CT severity

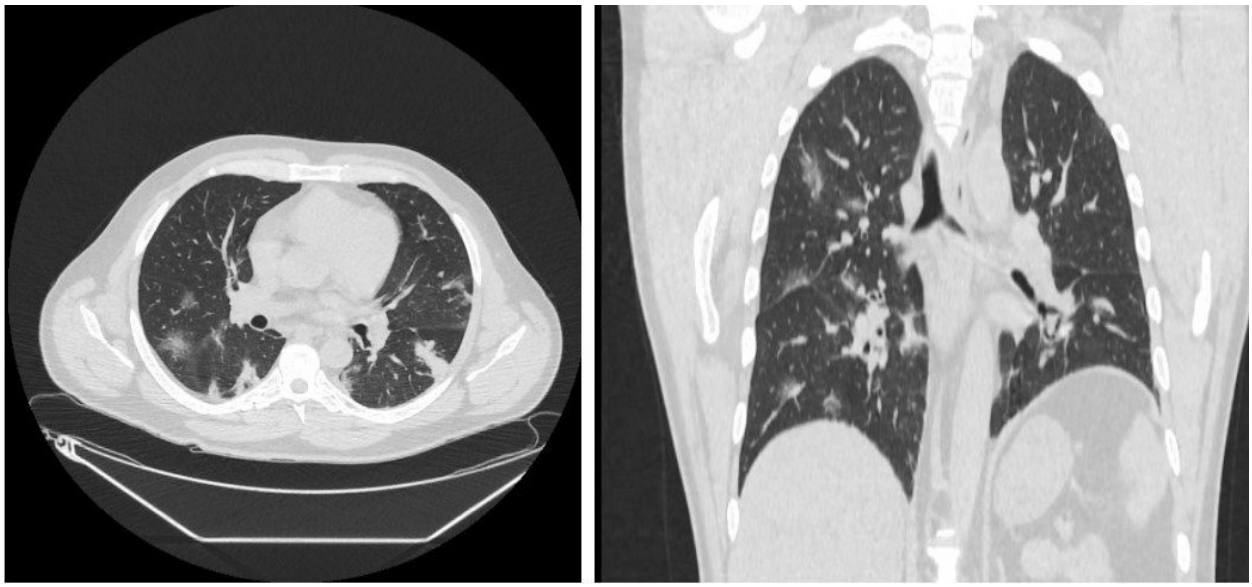
CT of severity	CT 1	CT 2	CT 3	CT 4
PCR / Positive	63/96,9%	14/60,9%	5/27,8%	0
PCR / negative	2/3,1%	9/39,1%	13/72,2	4/100,0%

From the data it can be seen that the greater the positive result, the greater the volume of lung damage i.e. on CT 1 of severity.

The CT picture of lung lesions was compared with the severity of clinical symptoms (fever, dry cough, nasal congestion, weakness, etc.). In 3 (2.7%) patients at the time of CT, the clinical picture of the disease was absent, despite the revealed CT signs of COVID-19-associated pneumonia and confirmation of the presence of SARS-CoV-2 by polymerase chain reaction.

Based on the analysis of the data obtained, various CT signs of viral pneumonia caused by SARS-CoV-2 were identified. The primary study was dominated by "frosted glass". Thus, a common symptom on CT of the lungs was “frosted glass” in all subjects. This sign is represented by a small compaction of the parenchyma without its volumetric change, with partial preservation of pneumatization, due to which bronchial and vascular structures are observed. In some foci, areas of high density were formed, clearly distinguished against the background of "frosted glass" (Fig. 2).

Figure 2. Patient M., 46 years old. PCR is positive. CT of the lungs, "pulmonary window", axial and coronary planes. On the periphery, areas of "frosted glass" with uneven and clear contrasts are determined



Most often, “frosted glass” was bilateral - in 87 (79.0%) patients, only subpleural lesions were detected in 23 (20.9%), but there were patients who only showed areas of “frosted glass” during CT examination both peripheral 15 (13.6%) and central localization - 9 (8.2%). Among the typical manifestations of the “ground glass” symptom, either confluent foci - in 74 (67.3%) cases, or rounded foci - in 36 (32.7%) cases were detected.

In 16 (14.5%) cases, there was a lesion of the dorsal regions, in 94 (85.4%) - chaotic lesion of different segments, both peripheral and central localization (Fig. 3-5).

Figure 3. Computer tomograms of the lungs. Patient 49 years old. The dorsal parts of the lungs are more affected. PCR test negative

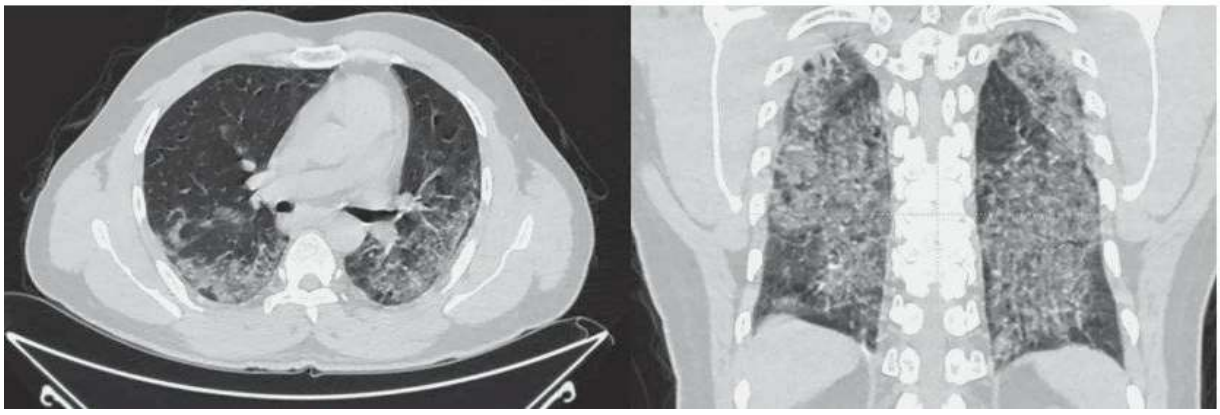


Figure 4. Computer tomograms of the lungs of high resolution. Patient 55 years old. The dorsal parts of the lungs are more affected. PCR test is positive

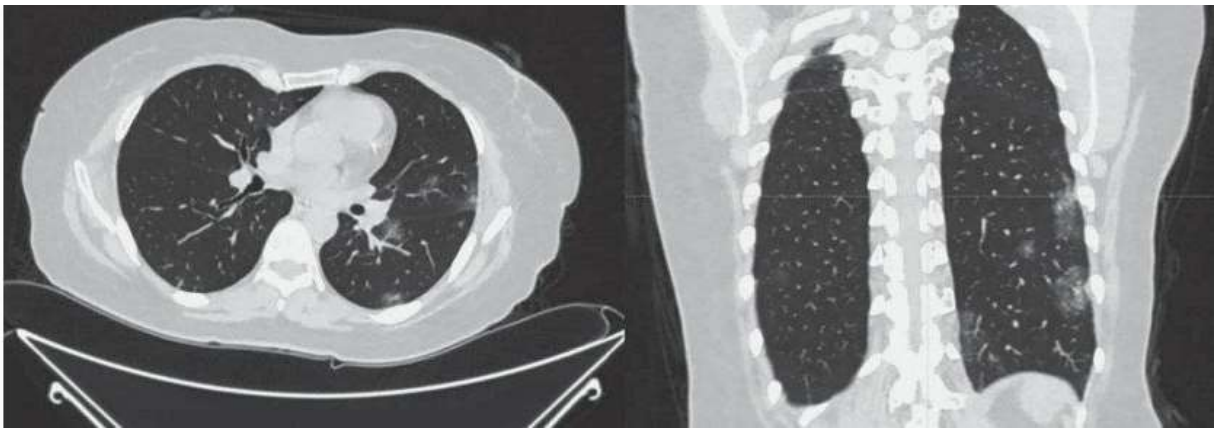
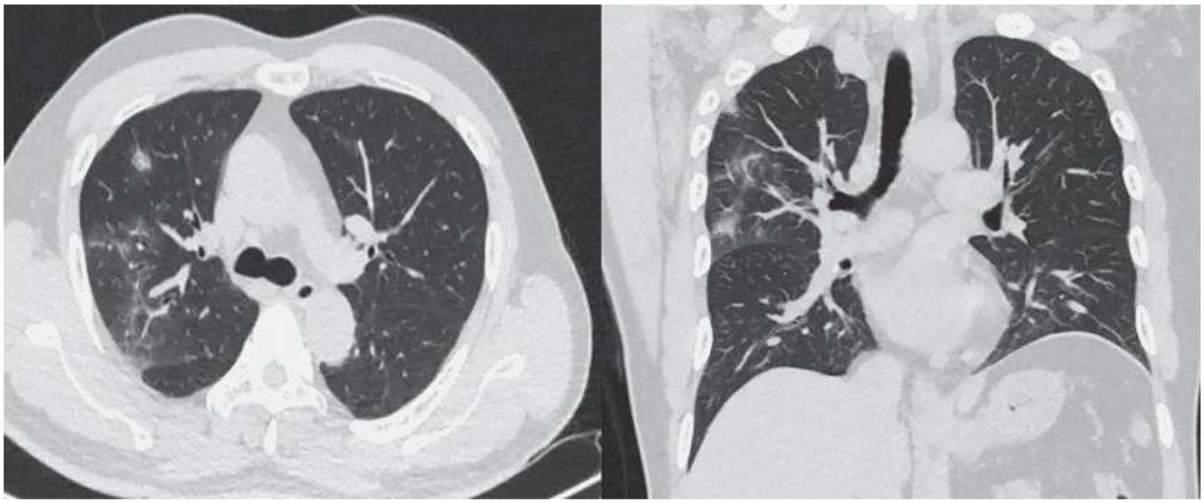
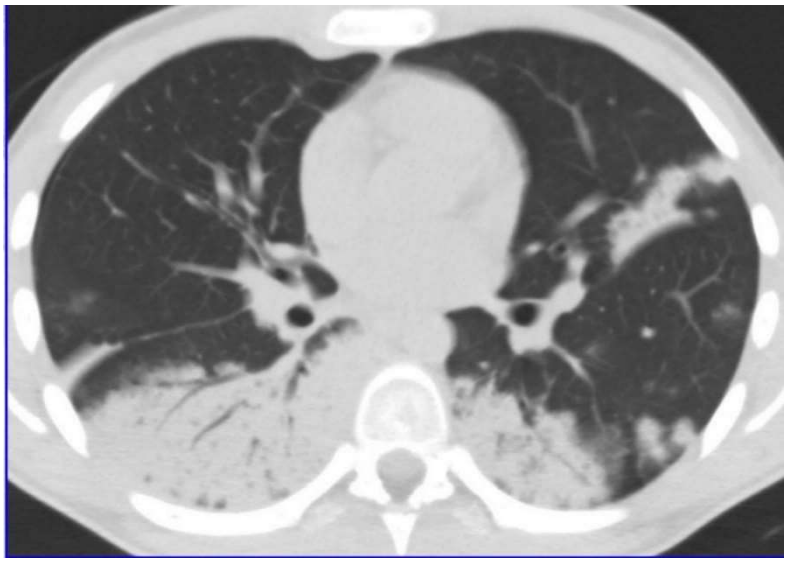


Figure 5. Computer tomograms of the lungs of high resolution. Patient 45 years old. The dorsal parts of the lungs are more affected. PCR test is positive



The second most frequent symptom was the consolidation of lung tissue; it was observed in 54 patients (49.1%). On tomograms, consolidation is characterized by a pronounced increase in the density of the parenchyma, against the background of which the bronchial structures and vessels are not differentiated due to is density compared to the affected area.

Figure 6. Patient N., 51 years old. PCR is negative. CT of the lungs - on both sides, an area of airless lung tissue is visualized with visible air gaps of the bronchi and air cavities. Vessels and walls of the bronchi in the zone of compaction are not visible



The cobblestone symptom is a combination of ground-glass changes and pronounced thickening of interstitial intra- and interlobular septa. This symptom occurred in 33 patients (30.0%).

Reticular changes represent a thickening of intra- and interlobular septa, as well as multiple curvilinear thickenings. The symptom was observed in 26 patients (23.6%). (Figure 4.).

Figure 7. Patient A., 46 years old. PCR is negative. CT of the lungs - on both sides there are thin lines of the pathologically altered pulmonary interstitium, forming a network.

Discussion

Based on the results of the analysis of the data obtained during the study in patients with SARS CoV-2 pneumonia, it was demonstrated that MSCT is a highly sensitive method for diagnosing pathological changes in the lung tissue. CT-semiotics of viral pneumonia COVID-19 described in the literature (numerous peripheral compactions of the lung tissue of the "ground glass" type, consolidation of lung tissue,

reticular changes, thickening of the pleura, subpleural enlightenment (like air stripes), symptom of air bronchogram, thickening of the interlobular interstitium of the “cobblestone” type (“crazy-paving” sign), “halo”, the opposite “halo” was clearly seen in our patients [12].

The most common sign of pneumonia is the appearance of focal changes of the "ground glass" type in its various modifications (presence of infiltration in the central zone, indistinctness, blurring of the outer contours). There is an increase in the pulmonary pattern due to edema of the interstitium by the type of cords, reticular macrostructure, up to the appearance of the "cobblestone" symptom, compaction of the pleura with the subpleural location of the focus. The most likely reason for the appearance of changes in the lungs of the "cobblestone" type in the first days of the disease is pronounced edema of the interlobular interstitium against the background of the "frosted glass" symptom. The changes were localized in any part of the lung, affected the alveolar tissue, caused a reaction of the interalveolar and pulmonary interstitium. The different prevalence and semiotics of COVID-19-associated pneumonia indicate a different body response to infection. The need to comply with certain methodological requirements when performing MSCT in patients with pneumonia caused by SARS-CoV-2 is emphasized. The effect of air bronchogram against the background of consolidations in our patients has always been preserved. That is, the bronchi and bronchioles with COVID-19 are passable and are almost not involved in the process in the absence of a bacterial infection.

It should be borne in mind that CT signs of COVID-19-associated pneumonia may lag behind or be ahead of the clinical symptoms of the disease in time. The pathomorphological substrate of changes in the lungs in the first days of the development of pneumonia against the background of SARS-CoV-2 infection, according to a number of authors, is dilatation and congestion in the capillaries of the alveoli, exudation of fluid into the alveolar cavity, edema of the interlobular interstitium, which is displayed on MSCT in the form of single or multiple changes of the "frosted glass" type, reticular consolidation of the interstitium, the draining nature of the changes and the appearance of high density foci against the background of "frosted glass".

We are more inclined to the leading theory, which is that the SARS-CoV-2 virus interacts with body tissues through receptors of the angiotensin-converting enzyme ACE-2, which are found in different tissues, most of them in the pulmonary parenchyma: in the pulmonary alveoli and in the bronchi, as well as in the nasopharynx, heart and blood vessels [15-17].

Conclusions

The most common sign of lung involvement on CT in a group of hospitalized patients is a decrease in ground-glass pneumatization.

Most of the hospitalized patients belong to the CT-1 group. And they have more PCR - a positive result. CT is a necessary research method when staging for COVID-19-associated pneumonia.

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