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Early Chest HRCT Findings and Dynamic Imaging Analysis of COVID-19 in Qinghai Province

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Abstract: This study aimed to analyze the early high-resolution CT (HRCT) manifestations and dynamic imaging changes of coronavirus disease 2019 (COVID-19) in Qinghai Province. A total of 24 nucleic acid-positive COVID-19 patients admitted to our hospital between January 2020 and November 2021 were included. All patients underwent HRCT examinations, and lesion characteristics—including number, distribution, morphology, and surrounding involvement—were analyzed. Among the 24 patients, systemic and respiratory circulatory symptoms were more common than other symptoms ($P < 0.05$). There were no significant differences in the lung lobes, relative positions, quantity, size, and density of lesions across different stages of the disease course ($P > 0.05$). Within the same disease stage, lesions were primarily located in the lower lobes of both lungs, the peripheral lung fields, and a combination of peripheral and central regions, with single and multiple lesions being the most common. Lesion morphology varied significantly across disease stages ($P < 0.05$), including differences between patchy and striped lesions, striped and massive lesions ($P < 0.05$), and patchy and massive lesions ($P < 0.05$). The incidence of striped lesions was higher in the progressive and recovery stages than in the early stage, showing an upward trend. There were no significant differences in pleural thickening, pleural effusion, mediastinal lymph node enlargement, or pericardial effusion across different disease stages ($P > 0.05$). Common HRCT signs observed at all stages included air bronchograms, paving stone patterns, halo signs, subpleural lines, and grid-like patterns. The main patterns of lesion progression were an increase in lesion size (16/24, 66.67%), an increase in the number of lesions (17/24, 70.83%), changes in lesion density (20/24, 80.33%), and localized lesion increase and partial absorption (6/24, 25.00%). In conclusion, the HRCT manifestations and evolution of lung lesions in COVID-19 patients are complex and varied, with a progressive increase in striped lesions potentially serving as a characteristic imaging feature of the disease.

Keywords: Coronavirus; Pneumonia; Chest HRCT; Imaging

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1. Introduction

At the end of 2019 and the beginning of 2020, many cases of pneumonia of unknown cause were diagnosed in multiple hospitals in Hubei Province, China. These cases were later confirmed to be caused by a novel coronavirus infection [1]. The virus quickly spread across the country, greatly affecting the physical and mental health of Chinese citizens. The National Health Organization named this virus SARS-CoV-2. This virus is highly infectious and has a wide range of transmission routes, posing a huge challenge to global healthcare [2]. As a newly emerging respiratory infectious disease, early detection, diagnosis, isolation, and treatment are essential. Conventional diagnostic methods primarily involve testing respiratory specimens and blood samples [3]. However, this diagnostic approach is highly susceptible to the quality of test kits, requiring a large number of test kits, and prone to false positives.

High-Resolution Computed Tomography (HRCT) of the chest is the primary diagnostic method for COVID-19, enabling the diagnosis of lesions [4]. It has high application value for determining the nature and severity of the disease. Additionally, HRCT provides superior image resolution compared to conventional chest CT, allowing for earlier diagnosis of the disease. Qinghai Province reported its first COVID-19 case on December 24, 2019. As of November 2021, Qinghai Province had 29 confirmed cases, with 24 of them being treated and isolated in our hospital. Based on this, we selected 24 nucleic acid-positive COVID-19 patients admitted between January 2020 and November 2021 as the study subjects to investigate the early chest HRCT manifestations and imaging analysis of COVID-19 in Qinghai Province.

2. Materials and methods

2.1. General information

The study subjects were patients with nucleic acid-positive COVID-19 admitted to our hospital between January 2020 and November 2021, including 14 male patients and 10 female patients. Their ages ranged from 7 to 80 years old, with an average age of (34.42 ± 10.58) years. The highest body temperature ranged from 36.0° to 39.5°, with an average highest body temperature of (37.1° ± 0.65).

Inclusion criteria for this study are: Patients who tested positive for both nucleic acid detection and respiratory specimen testing; Patients who underwent HRCT examination within one week of symptom onset.

Exclusion criteria include: Cardiopulmonary insufficiency; Hepatorenal insufficiency; Receives other treatments before admission; Patients with severe artifacts on chest HRCT examination.

2.2. Methods

2.2.1. Imaging examination

CT scans were performed on patients using the GE Optima 680 CT equipment with the following specific parameters: tube voltage of 120 KV, tube current set to automatic milliamperes, slice thickness of 5 mm, slice spacing of 5 mm, field of view of 500 × 500 mm, and a matrix of 512 × 512. Lung window reconstruction was achieved using a high-resolution algorithm, with the scanning range extending from the thoracic inlet to the base of the lungs. During image processing, multi-planar reconstruction, minimum intensity projection, and maximum intensity projection techniques were employed for image analysis.

2.2.2. Imaging analysis

Two radiologists with rich clinical experience reviewed the images, analyzing the lesion location, distribution, number, shape, density, consolidation, margins, and complications. In cases of disagreement, the two doctors would confer to provide accurate recommendations.

2.3. Observation Indices

The observation indices selected for this study were all related to HRCT, including the number of lesions, lesion distribution, lesion morphology, and surrounding involvement.

(1) Number and Distribution of Lesions

The number of segments involved by lesions was recorded, and the distribution around bronchial vascular bundles, subpleural regions, and scattered areas was analyzed.

(2) Lesion Morphology

The observed morphologies included nodular, mass-like, patchy, cord-like, extending towards the hilum, subpleural extension, cross-segmental, and cross-lobar.

(3) Surrounding Involvement.

2.4. Statistical Methods

Statistical analysis was conducted using SPSS 22.0 software. Measurement data were expressed as mean ± standard deviation and analysis of variance was used for comparisons between multiple groups. Count data were represented as relative numbers (rates) and chi-square tests were applied for comparisons between groups. A *P*-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of Clinical Symptoms

Among the 24 patients included in this study, systemic symptoms and respiratory and circulatory symptoms were found to be more common compared to other clinical symptoms ($P < 0.05$). Detailed data are presented in **Table 1**.

Table 1. Comparison of clinical symptoms in COVID-19 patient

System Name	Number of Cases (%)	*P*
Systemic symptoms	13 (54.17)	
Respiratory and circulatory symptoms	15 (62.50)	
Digestive system symptoms	5 (20.83)	< 0.05
Neurological symptoms	3 (12.50)	
Olfactory and Gustatory system symptoms	5 (20.83)	

3.2. Comparison of lesion quantity, location, distribution, and morphology results

According to the research results, there was no statistical significance in the comparison of lesion quantity, size, and density across different disease stages ($P > 0.05$). Within the same disease stage, the main distribution locations were the lower lobes of both lungs, the peripheral lung fields, and the peripheral + central regions, with single and multiple lesions being the most common. Among the morphologies of the lesions, there were certain differences based on different disease stages ($P < 0.05$), specifically in patchy vs. cord-like, cord-like vs. mass-like, and patchy vs. mass-like lesions ($P < 0.05$). The incidence rates in the progressive and recovery stages of the disease were higher than those in the early clinical stage, showing an upward trend. In the comparison of CT signs, no statistical significance was found in the data comparison across different disease stages ($P > 0.05$). See **Table 2** for details.

Table 2. Comparison of lesion quantity, location, distribution, and morphology results in COVID-19 patients at different disease stages

Indicator	Category	Early Stage (*n*=24)	Progressive Stage (*n*=24)	Recovery Stage (*n*=24)	*P*
Lesion quantity	Average quantity	27.21 ± 3.25	28.04 ± 3.87	28.01 ± 3.26	0.462
Lesion location	Right upper lung	2	1	1	< 0.001
	Right middle lung	2	3	2	
	Lower lobes of both lungs	7	6	8	
	Peripheral lung fields	6	7	6	
	Peripheral + Central	6	6	6	
	Right lower lung	1	2	1	
Onset pattern	Single	13	12	12	0.582
	Multiple	11	12	12	
Lesion morphology patchy	Patchy	5	7	8	< 0.001
	Cord-like	10	5	2	
	Mass-like	9	12	14	
CT signs	Pleural thickening	5	6	7	0.152
	Pleural effusion	6	6	5	
	Mediastinal lymph node enlargement	6	5	6	
	Pericardial effusion	7	7	6	

3.3. Analysis of lesion density at different stages

Research results indicate that among various stages of the disease, the most common signs include air bronchogram, crazy paving pattern, halo sign, subpleural line, and reticulation. Details are shown in **Table 3**.

Table 3. Analysis of lesion density at different stages for COVID-19 patients

Lesion Density	Early Stage (*n* = 24)	Progressive Stage (*n* = 24)	Recovery Stage (*n* = 24)
Pure consolidation	1 (4.17)	0 (0.00)	1 (4.17)
Ground-glass Opacity	1 (4.17)	1(4.17)	0 (0.00)
Air bronchogram	6 (25.00)	6 (25.00)	5 (20.83)
Crazy paving Pattern	4 (16.67)	5 (20.83)	6 (25.00)
Halo sign	4 (16.67)	5 (20.83)	6 (25.00)
Subpleural line	5 (20.83)	3 (12.50)	3 (12.50)
Reticulation	3 (12.50)	4 (16.67)	4 (16.67)

3.4. Analysis of disease progression patterns

In the statistical analysis of disease progression patterns, the main patterns observed include lesion enlargement, increase in lesion count, density changes, and localized increase or absorption of lesions. Details are presented in **Table 4**.

Table 4. Analysis of disease progression patterns for COVID-19 patients

Progression Pattern	Case	Count Proportion (%)
Lesion enlargement	16	66.67
Increase in lesion count	17	70.83
Density changes	20	80.33
Localized increase or absorption of lesions	6	25.00

4. Discussion

The novel coronavirus is one of the most infectious viruses discovered in recent years. As a β-genus positive-strand single-stranded RNA virus, it is characterized by small particle size and strong infectivity, with a diameter of only 100 nm [5]. It shares a high degree of similarity with bat-derived coronaviruses and pangolin β-coronaviruses. The novel coronavirus exists in many forms and has low stability, making it prone to mutations. Some research teams have directly pointed out that the novel coronavirus can mutate into three types, all of which are distributed globally [6].

According to current epidemiological data, COVID-19 patients are the main source of infection. Some patients have very subtle clinical symptoms, while virus carriers are potential sources of transmission. The virus can be transmitted through the air and in enclosed spaces, with a possibility of aerosol transmission. Studies have extracted blood and feces samples from COVID-19 patients for testing, and the novel coronavirus has also been detected, suggesting the possibility of mother-to-child transmission [7].

Generally, the incubation period of the novel coronavirus is about two weeks, with a median incubation period of one week and a maximum incubation period of three weeks. This virus has strong reproductive and replication abilities, significantly higher than other viruses. Due to the lack of antibodies against the novel coronavirus in the human body during the early stages of the disease, it is very easy to be infected. After infection with the novel coronavirus, the human body secretes antiviral interferons, but the novel coronavirus can still neutralize these interferons, making it difficult to detect the virus after infection [8].

In the early clinical stage, the main symptoms are dry cough, fever, fatigue, etc [9]. Some patients may also experience diarrhea, sore throat, and nasal congestion. The total white blood cell count may decrease, procalcitonin levels remain normal, and C-reactive protein (CRP) may show a significant increase. Attention should be paid to these symptoms in the early clinical stage. Studies have confirmed that the lower respiratory tract has relatively weak defenses, so the novel coronavirus may attack the subpleural alveolar tissue, causing diffuse damage to the airways [10]. The lesions may involve the lung interstitium. Pathologically, inflammatory cell infiltration and vascular fluid leakage may also occur.

Based on this, this study focused on 24 nucleic acid-positive patients with COVID-19 who were admitted to our hospital between January 2020 and November 2021. We investigated the imaging manifestations of high-resolution chest CT scans in COVID-19 patients in Qinghai Province. The research results indicated that systemic symptoms and respiratory and circulatory symptoms of the novel coronavirus were more common ($P < 0.05$). During the progression of the disease, there was no statistically significant difference in the location, size, relative position, and density of lesions across different stages of the disease ($P > 0.05$).

Within the same disease stage, the lesions were primarily located in the lower lobes of both lungs, the periphery of the lungs, and a combination of peripheral and central regions, with single and multiple lesions being the most common. Among lesion morphologies, there was a statistically significant difference based on different disease stages ($P < 0.05$). The incidence of cord-like lesions was higher in the progressive and recovery stages compared to the early stage, showing an upward trend.

Among the CT signs, there was no statistically significant difference in pleural thickening, pleural effusion, mediastinal lymph node enlargement, and pericardial effusion across different stages of the disease ($P > 0.05$). Based on different stages of the disease, the main CT signs observed were air bronchogram, crazy-paving pattern, halo sign, subpleural line, and reticulation. Disease progression primarily included an increase in lesion size, an increase in the number of lesions, changes in lesion density, and local increases or resolution of lesions.

In summary, regarding the HRCT manifestations of the novel coronavirus, the HRCT findings and their evolution are quite complex. Chest HRCT plays a significant role in screening for COVID-19. As the disease progresses, cord-like lesions may be one of the important characteristic manifestations. However, the sample size of this study was relatively small and more cases will be included in subsequent studies to ensure data reliability.

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Disclosure statement

The authors declare no conflict of interest.

References

[1] Majrashi NAA, 2023, The value of chest X-ray and CT severity scoring systems in the diagnosis of COVID-19: A review. Frontiers in Medicine, 9: 1–10.

[2] Gao Y, Yao J, Xiang R, et al., 2020, HRCT Manifestations of COVID-19 Discovered During the First Diagnosis. Journal of Qiannan Medical College for Nationalities, 33(2): 79–82.

[3] Huang M, Lei W, Mei H, 2020, Early Chest HRCT Manifestations of COVID-19. Primary Medical Forum, 24(25): 3648–3650.

[4] Tong H, Xu Y, Yang B, et al., 2020, Diagnostic Value of HRCT Imaging for COVID-19. International Journal of Medical Radiology, 43(2): 135–139.

[5] Lv H, Che Q, Ji X, et al., 2020, Chest High-Resolution CT Manifestations of COVID-19. Journal of Practical Radiology, 36(9): 1388–1391.

[6] Zhang Y, Xin X, Yang W, et al., 2022, Analysis of HRCT Imaging Features of COVID-19. Chinese Journal of CT and MRI, 20(1): 55–57.

[7] Yao Q, Zhang C, Fu J, et al., 2020, High-resolution CT Manifestations and Evolution of COVID-19 in the Chest. Journal of Practical Medicine, 36(12): 1552–1557.

[8] Zhao W, Ren Q, Zhu H, et al., 2020, HRCT Imaging Manifestations and Clinical Characteristics of COVID-19 at Different Clinical Stages in Huaibei Area. Clinical Medicine, 40(9): 7–9.

[9] Zhang T, Zhao Y, Ye M, et al., 2020, Chest HRCT Manifestations of 5 Patients with COVID-19. Journal of Xinjiang Medical University, 43(3): 250–252.

[10] Liu Z, Zhang S, 2020, Clinical and HRCT Manifestations of COVID-19. Youjiang Medical Journal, 48(9): 656–659.