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Comparative Analysis of Clinical Manifestations and CT Scores in Imported versus Secondary COVID-19 Cases in Wuhan: Prognostic Implications of CT Imaging

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Abstract

This study aimed to explore the characteristics of coronavirus disease 2019 (COVID-19) in terms of clinical manifestations and CT scores in pneumonia patients, as well as the role of CT in prognostic follow-up. The clinical manifestations and CT data of 9 imported COVID-19 patients and 7 second - generation imported COVID-19 patients admitted to our hospital were retrospectively analyzed. Siemens 16 - slice high - resolution CT was used for scanning. The clinical data of the enrolled patients were collected, and CT scores for lung lobes and segments were performed. Independent sample t - test and Fisher's exact probability method were used for comparison to analyze the clinical and imaging differences between the two groups of pneumonia patients and their relationships with prognosis. The results showed that there were no differences in clinical manifestations between the two groups of COVID-19 patients, but there were statistical differences in CT scores. Imported pneumonia patients had higher lung CT scores, more severe illness, more serious lung damage, more obvious pulmonary fibrosis during follow-up reexamination, and worse prognosis. In conclusion, imported and second - generation imported COVID-19 patients in Wuhan had common clinical manifestations but different lung CT scores. CT can be used to evaluate the severity of lung damage in COVID-19 pneumonia patients and dynamically monitor the treatment efficacy and prognosis.

Keywords: coronavirus disease 2019, clinical characteristics, CT score, prognostic follow-up

1. Introduction

The outbreak of coronavirus disease 2019 (COVID-19) has brought a huge challenge to global public health. Understanding the clinical characteristics, imaging manifestations, and their relationships with prognosis of different types of patients, such as imported and second - generation imported patients, is of great significance for precise treatment and prevention and control. As an important imaging examination method, CT plays a key role in the diagnosis, disease assessment, and prognostic monitoring of COVID-19. This study aimed to deeply explore the characteristics of COVID-19 in terms of clinical manifestations and CT scores in pneumonia patients, as well as the role of CT in prognostic follow-up.

2. Materials and Methods

2.1 General Information

A total of 16 patients with COVID-19 who were clinically diagnosed (confirmed by positive nucleic acid test) from January 28, 2020, to February 10, 2020, were collected and sorted. The overall average age was 48.6 years old. According to the epidemiological history in the latest (5th edition) diagnosis and treatment plan for COVID-19, the patients were divided into two groups. The imported group returning from Wuhan (Group A, 9 cases, male:female = 5:4, with an average age of 41.7 years old) and the second - generation contact - imported group (Group B, 7 cases, male:female = 4:3, with an average age of 55.5 years old) (see Table 1).

2.2 Examination Methods

High - resolution CT plain scan of the chest: The scanning range was from the apex of the lung to the base of the lung. Scanning was performed with breath - holding at the end of expiration to ensure clear image quality and meet the diagnostic requirements.

Criteria for lung CT scoring:

Lung lobe scoring [2]: Scoring was carried out according to the range of lung lobes involved by the lesions. 0 point: not involved; 1 point: 1 - 25%; 2 points: 26 - 50%; 3 points: 51 - 75%; 4 points: 76 - 100%; The total score was the sum of all scores.

Lung segment scoring (Expert Group of the Radiologist Branch of the Chongqing Medical Doctor Association): Each lung segment with lesions was scored 1 point. If the involved range exceeded half, an additional 1 point was added. If consolidation occurred, an additional 1 point was added. If the consolidation range was greater than 50%, an additional 1 point was added. The maximum total score was limited to no more than 60 points. Finally, the inflammation index (total score / 60) was obtained, which was distributed between 0 - 100%.

Description of main imaging signs: Ground - glass opacity, consolidation, thickening of interlobular septa, vascular thickening, bronchiectasis, pleural effusion, lymph node enlargement, etc. were recorded as 1 if present and 0 if absent.

Image analysis: Two cardiothoracic group doctors independently read and scored the films. When there was a disagreement, the two doctors discussed and reached an agreement through consultation.

2.3 Statistical Analysis

SPSS 19.0 software was used for statistical analysis. Measurement data were expressed as mean ± standard deviation, and $p \leq 0.05$ was considered statistically significant. Count data were expressed as percentages. The chi - square test or Fisher's exact probability method was used for the comparison of clinical and CT signs among NCP patients.

2.4 Results of Clinical Data of Patients in Different Groups

The results of clinical data of patients in different groups are shown in (Table 1).

Table 1. Clinical Data

Clinical Characteristics	Imported Group	Second-Generation Imported Group	Total	p
Number of Cases	9	7	16	
Age (y)	41.7(6-71)	55.6(43-76) 4.3±14.6)	48.6(6-75)	
Gender (Female/Male)	5/4	3/4	8/8	
Incubation Period (day)	7.5(2-12)	8.8(4-13)	8.1(2-13)	
First CT Time (day)	11.5±3.5	10.4±2.4	10.9	
Second CT Time (day)	14.3（6/9）	14.4(6/7)	14.35(12/16))	
Third CT Time (day)	19.5(4/9)	21(3/7)	20.2(7/16)	
Temperature (℃)	37.95(8/9)	37.55(4/7)	37.75(12/16)	
Symptoms				
Fever	8/9(88.9%)	4/7(57.1%)	12/16	0.302
Fatigue	3	1/7(14.2%)	4/16(25%)	0.674
Dry Cough	5/9(55.6%)	4/7(57.1%)	9/16(56.2%)	0.671
Diarrhea	2/9(22.2%)	3/7(42.8%)	5/16(31.2%)	0.585
Shortness of Breath	2/9(22.2%)	3/7(42.8%)	5/16(31.2%)	0.596
Muscle Soreness	1/9(11.1%)	0/7	1/16(6.2%)	0.438
Complications				
Hypertension	1	2	3	0.537
Diabetes	2	2	4	1
Cardiovascular Disease	1	0	1	0.438
COPD	0	1	1	0.438
Chronic Kidney Disease	1	0	1	1
Laboratory Indicators				
WBC(×109/L)	3.32±1.64	4.6±1.29	3.97±1.25	
LY Lymphocyte Count (×10⁹/L)	21.7±9.7	23.0±9.4	22.3±9.55	
PCO2	31.0±5.0	38.2±4.9	34.6±4.9	
PO2	97.7±46.6	154.9±45.8	126.±46.2	
Oxygen Saturation	20.9±1.8	36±30.6	22.5±16.2	

CT Manifestations of the Two Groups of Patients

2.4.1 Basic Patient Information

The ages of 16 confirmed patients ranged from 6 to 76 years old, with a median age of 45 years old. The incubation periods of 9 returnees from Wuhan (Incubation period: For the imported group returning from Wuhan, it was from leaving Wuhan to the onset of the disease; for the second - generation contact - imported group, it was from contacting the imported group from Wuhan to the onset of the disease) were 2 - 12 days, with a median incubation period of 9 days and an average incubation period of 7.5 days. The incubation periods of 7 second - generation contacts of imported cases were 4 - 13 days, with a median incubation period of 9 days and an average incubation period of 8.8 days. There was no statistical difference ($p = 0.309$). Underlying diseases included 3 cases of hypertension, 1 case of hyperlipidemia, 1 case of renal failure, 1 case of coronary heart disease, 4 cases of diabetes, 1 case of rheumatoid arthritis, 1 case of COPD, and 1 case after lung cancer surgery.

2.4.2 Clinical Symptoms and Signs

There were 12 cases of fever, 4 cases of fatigue, 5 cases of diarrhea, 9 cases of expectoration, 5 cases of shortness of breath, 9 cases of dry cough, 1 case of hematochezia, and 1 case of muscle soreness.

2.4.3 Laboratory Indicators

Among the 16 confirmed patients, the total number of peripheral blood white blood cells was normal or decreased in 9 cases (9/16), lymphocyte count was decreased in 6 cases (6/16), neutrophil count was increased in 4 cases (4/16), and 1 patient had an increase in myoglobin (610.6, normal range 0 - 110). PCO_2 was decreased in 4 patients, and PO_2 was decreased in 2 patients.

The main signs in CT manifestations of the two groups of patients were ground - glass opacity, consolidation, thickening of interlobular septa, vascular thickening, and bronchitis [3] (see Figures 1 and 2). Fisher's exact probability test was used for the above - mentioned signs, and $p > 0.05$, indicating no statistical significance between the two groups.

2.4.4 Lung CT Scoring

Lung Lobe Scoring: There was no statistical difference between the two groups in the first and second CT examinations. In the third CT re - examination, there was a statistical difference between the imported group and the contact group. That is, the CT score of the imported group was significantly higher than that of the contact group. Combined with CT manifestations, it was confirmed that the condition of the imported group was more severe.

Lung Segment Scoring: The first and second CT re - examinations showed that the score of the imported group was higher than that of the contact group, reflecting that the lung changes in the imported group were more severe and the involved range was wider. The third CT re - examination showed that although the score of the imported group was higher than that of the contact group, there was no statistical difference between the two groups.

No pleural effusion or lymph node enlargement was observed in the enrolled patients.

Table 2. CT Imaging Signs and Lung Lobe/Segment Scores of the Two Groups of Patients

Group	**First CT**	**Second CT**	**Third CT**
Total	16	7	7
Ground - Glass Opacity (%)	13/16(%)	7/7	7/7
Imported Group	7/9	4/4	4/4
Second- Generation Imported Group	6/7	3/3	3/3
p	1	-	-
Consolidation (%)	14/16(%)	7/7	6/7
Imported Group	8/9	4/4	4/4
p	1	-	-
Second- Generation Imported Group	6/7	3/3	2/3
Thickening of Interlobular Septa (%)	14/16(%)	4/7	6/7
Imported Group	8/9	2/4	4/4
Second- Generation Imported Group	6/7	2/3	2/3
p	0.55	1	0.429
Vascular Thickening (%)	12/16(%)	5/7	4/7
Imported Group	8/9	3/4	3/4
Second- Generation Imported	4/7	2/3	1/3

Group			
p	0.262	1	0.486
Bronchitis (%)	11/17(%)	4/7	5/7
Lung Lobe Score			
Imported Group	5.9±3.3	8.75±4.3	7±1.8
Second- Generation Imported Group	2.0±1.4	2.7±1.5	4
P	0.191	0.172	0.007
Lung Segment Score			
Imported Group	20.5±12.9	26±17.3	24.7±10.8
Second- Generation Imported Group	4±2.8	5.3±3.5	14.3±8.1
P	0.003	0.034	0.124

3. Discussion

Novel coronavirus pneumonia (NCP), abbreviated as COVID-19, is caused by the novel coronavirus. The World Health Organization (WHO) officially named this disease as coronavirus disease 2019 (COVID-19). As of February 15, 2020, there were 66,576 confirmed cases in China, including 48,175 cases in Hubei, 1,524 deaths, 470 cases in Sichuan, and 17 cases in Deyang.

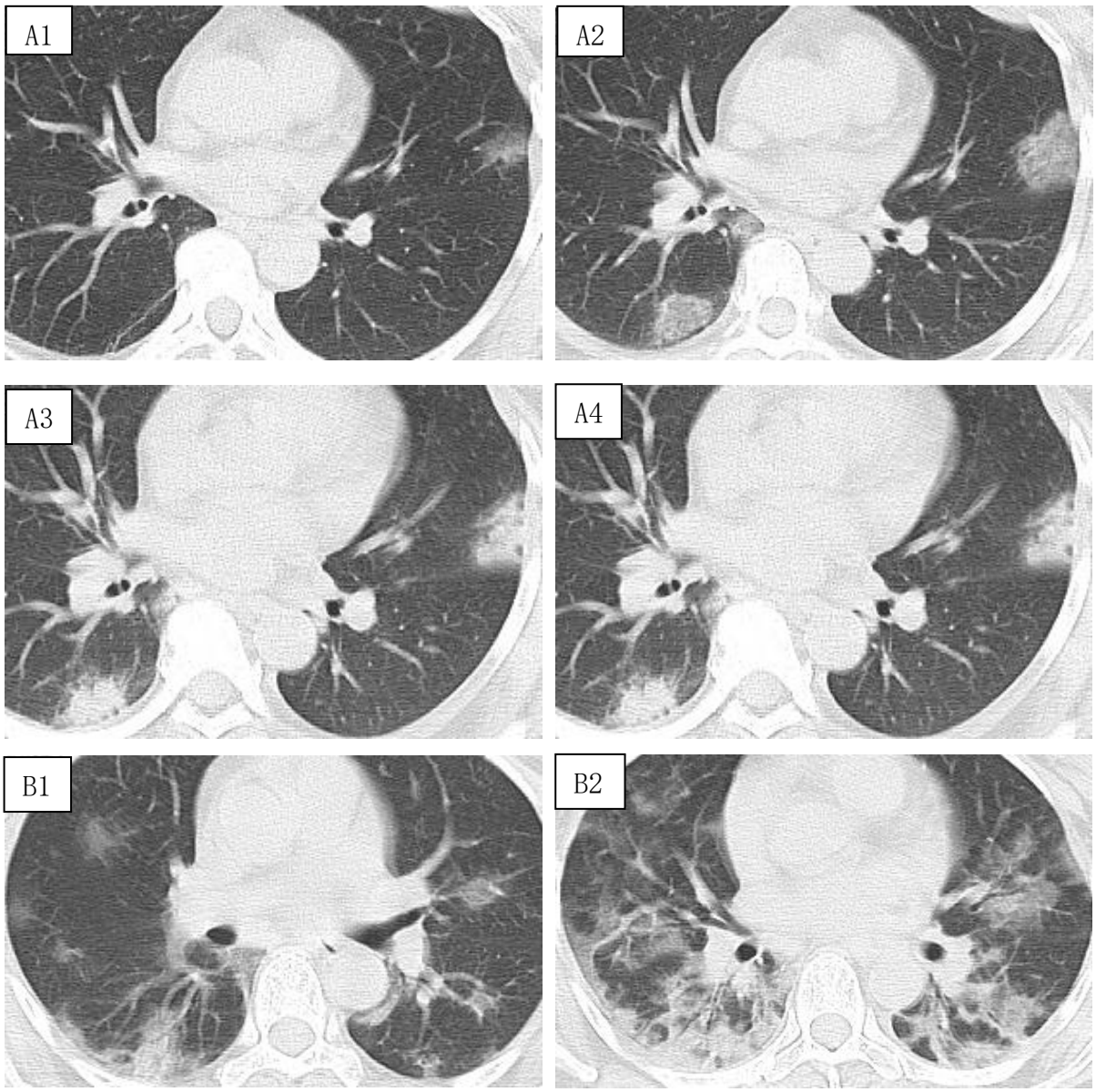
Coronavirus is a single - stranded positive - sense RNA virus belonging to the order Nidovirales, subfamily Coronavirinae. Currently, four genetic phenotypes are known, namely α, β, γ, and δ. Among them, α and β are prone to infect mammals [4]. 2019 - nCoV belongs to the β genus. Gene sequencing analysis shows that it is different from severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) [5]. It is closer to the SARS - like coronavirus in Rhinolophus sinicus, with a nucleotide homology of more than 85%, and a homology of 50% with MERS that causes Middle East respiratory syndrome [5].

The diagnosis of NCP mainly relies on epidemiology, typical clinical symptoms, CT manifestations, and NCP nucleic acid testing [4, "Diagnosis and Treatment Plan for Novel Coronavirus Pneumonia (Trial Version 5, Revised Version)"]. Although nucleic acid testing was considered the gold standard for diagnosis in the initial diagnosis, it was found in clinical applications that the false - negative rate of test results collected from pharyngeal swabs was relatively high. Therefore, the imaging features of pneumonia were newly added in the "Diagnosis and Treatment Plan for Novel Coronavirus Pneumonia (Trial Version 5, Revised Version)".

The cases in our study showed that both groups of patients presented with fever, fatigue, dry cough, shortness of breath, and muscle soreness, with fever being the most common, accounting for 89.6%, usually < 38 °C. The proportion of each symptom in the two groups of patients is shown in (Table 1). Among the cases enrolled in our hospital, there were 4 severe cases, all from the imported group. On CT, they showed multiple patchy and sheet - like ground - glass opacities and consolidations in both lungs, multiple thickenings of interlobular septa, and local fine reticular shadows, mainly in the periphery of both lungs, gradually involving the middle zone of both lungs, with an involved range of about 0% - 85% (including a 6 - year - old child with a positive nucleic acid test but negative clinical symptoms and imaging manifestations). The incubation period of this group of patients was 4 - 11 days. The time from the onset of the disease to the first CT examination was about 9 - 12 days, the second CT time was about 11 - 16 days, and the third CT time was about 16 - 21 days. CT images showed that from the onset of the disease to the second or third CT examination, the imaging manifestations of both lungs were the most severe. At this time, the involved range of both lungs was about 55% - 85%, and the ground - glass opacities in both lungs further consolidated, and the scope of some areas expanded. By the fourth CT examination, the consolidations and ground - glass opacities in both lungs gradually decreased, and the interlobular septa and interstitial changes gradually became obvious, mainly in the outer zone of both lungs (Table 3, Figures B1 - 4), and the CT score gradually decreased.

For the second - generation imported NCP patients, as shown in Figures A1 - A4, a 43 - year - old female presented with fever (37.3 °C), fatigue, and shortness of breath. Four CT re - examination images were taken on January 31, 2020, February 4, 2020, February 9, 2020, and February 13, 2020, respectively. In Figures A2 and A3, the lesion area gradually changed from ground - glass opacity to consolidation, and dilated bronchi appeared in the lesion area. When the CT was re - examined for the fourth time, the lesion range narrowed, and small air - bubble shadows appeared in the lesion area, mainly in the sub - pleural area. The second - generation imported patients had lower CT scores for lung lobes and segments (Table 4), and the involved range was more limited than that of the imported patients. After treatment, the ground - glass opacities and consolidations decreased, and the ground - glass opacities could gradually absorb and even disappear completely [6].

For the imported NCP patients, as shown in Figures B1 - B4, a 48 - year - old female presented with fever (37.6 °C), fatigue, expectoration, and shortness of breath, without comorbidities. Four CT re - examination images were taken on January 31, 2020, February 4, 2020, February 9, 2020, and February 15, 2020, respectively. Figure B1 showed multiple ground - glass exudative shadows in both lungs, with local patchy consolidation in the dorsal segment of the lower lobe of the right lung. Figure B2 showed a significant increase in the lesion range in both lungs, with an increase in the scope of the consolidation area and the appearance of air - bronchogram signs within the consolidation area. In Figure B3, the consolidation range in both lungs decreased with absorption, and the interlobular septa in the original lesion area thickened, accompanied by the appearance of fibrous cords. Figure B4 showed a further reduction in ground - glass opacities in both lungs, with more obvious interstitial fibrosis changes.This study demonstrated differences in the disease severity and imaging manifestations between imported and second - generation imported NCP patients. The imported group had more severe conditions, as reflected by higher CT scores and a wider range of lung involvement. The differences in clinical and imaging features between the two groups may be related to factors such as the initial virus load and the body's immune response. However, due to the relatively small sample size in this study, the conclusions drawn need to be further verified by large - scale studies. Additionally, continuous monitoring of CT images is crucial for evaluating the disease progression and treatment efficacy of NCP patients, which can provide important references for clinical decision - making.



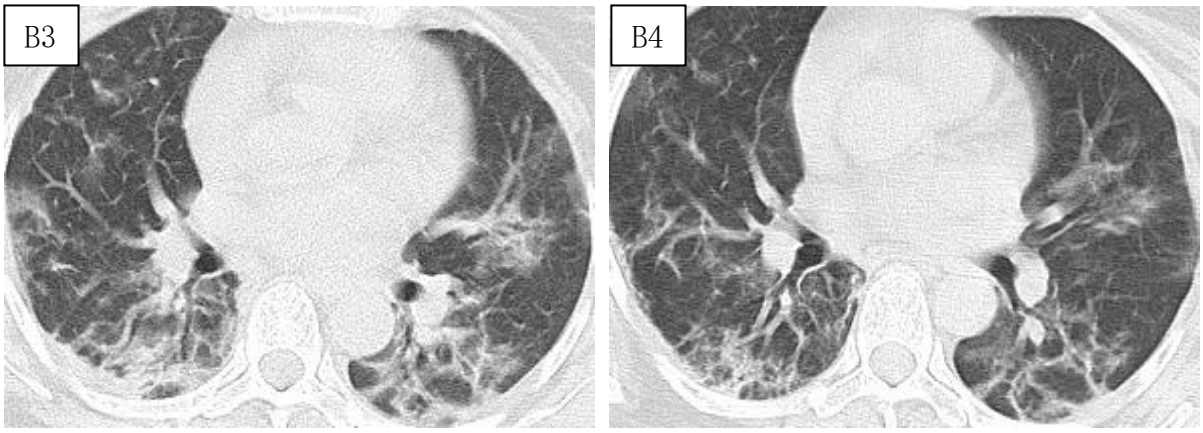


Figure 1. A1-A4 is a 43-year-old female input type second-generation NCP patient who was treated with fever (37.3°C), fatigue/tightness of breath. CT reexamination images were conducted on January 31, 2020.2.4, 2020.2.9, and February 13, 2020.respectively. The lesion area in FIG. A2 and A3 gradually changed from ground glass shadow to solid lesion. Dilated bronchus appeared in the lesion area, and the lesion area was reduced at the 4th CT reexamination, and small vacuoles appeared in the lesion area, mainly in the subpleural area.

Firstly, at the beginning, the initially imported group did not attract enough attention, resulting in a relatively delayed time for seeking medical treatment. Therefore, there was inconsistency in the examination time. However, with the deepening of people's understanding and attention towards COVID-19, close contacts have been under strict isolation and observation, and the process from the onset of symptoms to seeking medical treatment and obtaining imaging examination data has become more timely. Secondly, after making a clear diagnosis as early as possible and taking corresponding treatment measures for intervention in a timely manner, the disease progression can be slowed down to a certain extent, and the lung damage can be reduced. Thirdly, the virus has the characteristic of reduced virulence during the process of transmission. For the above reasons, the patients in the group with contact history in Wuhan showed milder manifestations on lung CT scans and had lower CT scores.

During the clinical diagnosis and treatment process, multiple CT reexaminations enable NCP patients to dynamically understand the treatment effect, providing a basis for adjusting the treatment plan in a timely manner.

Although NCP patients have diverse clinical manifestations, CT can detect minor lung lesions, analyze the distribution and imaging manifestations of the lesions, and obtain their imaging characteristics. At the same time, CT can objectively reflect the affected parts and scope of the lungs. The accurate scoring of lung CT can further quantify the degree of lung involvement, which not only helps to understand the initial situation of lung involvement but also contributes to the evaluation of treatment efficacy and prognostic follow-up during clinical treatment.

4. Conclusion

The imported type and imported second-generation NCP patients in Wuhan have the same clinical manifestations, but different lung CT scores, and CT can evaluate the severity of lung injury in patients with NCP pneumonia and dynamically monitor the therapeutic effect and prognosis of patients.

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