

PATIENTS INFECTED WITH THE OMICRON VARIANT OF SEVERE ACUTE RESPIRATORY SYNDROME CORONAVIRUS 2: INITIAL CHEST CT FINDINGS AND TEMPORAL CHANGES

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Abstract: Background: Omicron has higher transmissivity compared to previous strains, and clinical manifestations are not identical. To date, few studies have examined the imaging characteristics of Omicron. Methods: The patients undergo one or more CT examinations. The radiologist analyzed abnormal lung patterns and how these characteristics changed over time. Results: 18 patients (4.9%, 18/364) had viral pneumonia on chest CT, 14 had follow-up CT, and 11 had three or more CT examinations. 11 patients (11/14) had the most lung segments affected by pneumonia at the initial CT and then decreased. Three patients (3/14) had fewer lung segments affected by pneumonia during the first CT examinations, and the number increased during the follow-up CT, two were elderly with basic diseases and unvaccinated. Ground-glass opacity (GGO) was the primary abnormality at the first CT in seven patients (7/11). Then GGO decreased, and mixed lesions appeared in two patients. On the third CT, 5 patients showed complete absorption of pneumonia (5/11), and the residual lesions were pure GGO (2/11) or mixed GGO (4/11). Conclusion: Pneumonia is rare in patients with Omicron and is absorbed quickly, but pneumonia lasts longer in patients with underlying illnesses or those who are older.

Keywords: COVID-19; Omicron; CT.

1. INTRODUCTION

Coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has rapidly spread throughout the globe. As of 17 January 2023, over 0.66 billion diagnosed cases and 6.7 million deaths have been reported worldwide [1]. Over time, SARS-CoV-2 continues to evolve into multiple variant strains that differ in spreading and virulence, including the Alpha (B.1.1.7), Beta (B.1.351), Gamma (P.1), Delta (B.1.617.2), and Omicron (B.1.1.529) variants, etc. Since its first report in South Africa in November 2021, Omicron has quickly become the dominant strain worldwide [1]. Compared to previous strains, Omicron has higher viral transmissivity with a certain immune-evasion capacity, which makes the current vaccines less effective [2-6]. In addition, clinical manifestations associated with Omicron infections are not identical to those of infections with other strains [4]. Given these features, the infection caused by the Omicron strain becomes more occult.

To date, few studies have examined the imaging characteristics of Omicron infections [7, 8]. In the Omicron variant, pneumonia tends to spread around the bronchi and blood vessels, affecting a small area of the lungs. In addition, patients receiving increased doses of vaccines have a significantly reduced severity of pneumonia than patients who are not vaccinated, but no study tracks the changes of pneumonia on chest CT over time. The current study retrospectively analyzed the imaging findings of Omicron-infected patients and the time difference.

2. MATERIALS AND METHODS

2.1 Patient Selection

This retrospective study evaluated hospitalized patients with COVID-19 between January 13, 2022, and March 31, 2022. A real-time single nucleotide polymorphism test was used to detect the Omicron variant; all cases were subvariant BA.2. All participants underwent pulmonary computed tomography (CT) on admission.

Follow-up CT was scheduled for patients with pulmonary signs of viral infection or worsening of disease during treatment. Ethical approval was obtained from the Research Ethics Committee of the Fifth Affiliated Hospital of Sun Yat-sen University for this retrospective observational study. Since the study was retrospective, informed consent was waived.

2.2 Chest Ct Scan Devices And Techniques

Following routine pulmonary imaging, patients were placed in a supine position with both arms raised. Scanning was initiated during breath-holding at full inspiration. The scan included the entire lung volume.

KAIPU CT (Campo imaging) or GE Revolution Max CT (GE Medical Systems) was used with the following parameters: KAIPU CT-tube voltage, 120 kV; tube current, 200 mA; pitch, 1.26; layer thickness, 1.1 mm; GE Revolution Max CT-tube voltage, 120 kV; tube current, 350 mA; pitch, 0.984; layer thickness, 1.25 mm. All devices and the CT department were thoroughly disinfected before the examination of another patient.

2.3 Interpretation Of Ct Image Findings

Two radiologists with 13 years of experience evaluated the chest CT images independently. Any discrepancies in the results were resolved through discussion. The patients were divided into different groups based on their final diagnosis, with the pulmonary infection group as the positive group. According to the Fleischner Society and peer-reviewed literature on viral pneumonia, the main CT patterns were described [9,10]. The CT images were analyzed to determine whether ground-glass opacity (GGO), consolidation, stripe, or mixtures of the two or three lesions were present (Figure 1). The maximum possible score for pneumonia was 18 based on statistics of the lung segments involved.

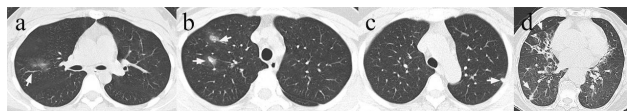


Fig. 1 Chest CT manifestation types of lesions among the included patients. The white arrows indicate the abnormalities. a. GGO; b. GGO+ consolidation; c. Consolidation; d. GGO + consolidation + stripe. GGO: ground glass opacity.

2.4 Statistical Analysis

SPSS 23.0 (IBM Corporation) is used for the statistical analysis. Data are expressed as mean ± SD. Categorical variables are presented as counts and percentages.

3. RESULTS

In all, 364 patients were enrolled. There were 191 male (52.5%) and 173 female (47.5%) patients, aged between 18 and 90 (Mean ± standard deviation, 40.3 ± 15.3) years, 183 infections (50.3%) were asymptomatic, and Table 1 displayed the specific symptoms of symptomatic

infections. Vaccination records of 19 patients (5.2%) were unknown whereas vaccination was not performed on 11 patients (3.0%), 1 dose for 9 patients (2.5%), 2 doses for 144 patients (39.6%), and 3 doses for 181 patients (49.7%). Viral pneumonia occurred in one patient of the vaccination unknown group (1/19, 5.3%), two of the unvaccinated group (2/11, 18.2%), one of the one dose group (1/9, 11.1%), six of the two doses group (6/144, 4.2%), and seven of the three doses group (7/181, 3.9%), respectively. An overview of vaccinations and pneumonia is provided in Table 1. No patients with severe or critical COVID-19 were included in this study. There was at least one CT exam performed on every patient. 18 patients (4.9%, 18/364) tested positive on CT, and 14 patients received 2-6 CT scans. In the 14 patients, 5 (1,16) [median (minimum–maximum)] lung segments were involved on average. In 11 of the 14 patients, pneumonia affected the most lung segments during the first CT examination, with 59 segments in total, but the number decreased rapidly, followed by 45 and 36. The lung lesions of three patients disappeared during the second CT examination, so the third CT examination was not performed. The 11 patients are young (age from 21 to 48), without basic diseases, and have been vaccinated with two to three shots. An example of the rapid absorption of a lesion is shown in Figure 2. In the other 3 patients, the number of lung segments involved in pneumonia was less during the first CT examination and gradually increased during the second and third CT examinations. Two of the three patients were elderly, aged 90 and 74 years, with basic diseases and were not vaccinated. The dynamic changes in the lung can be seen in Figure 3.

Table 1 Summary of Patient Characteristics (n = 364)

Parameter	Value
Sex	
Male	191(52.5%)
Female	173(47.5%)
Age	
Mean	40.3
Standard deviation	15.3
Range	18-90
Symptoms	
No obvious symptoms	183(50.3%)
Pharyngeal discomfort	103(28.3%)

Fever	49(13.5%)
Cough	75(20.6%)
Headache	24(6.6%)
Muscle soreness	18(5.3%)
Fatigue	16(4.4%)
Nasal congestion	22(6.0%)
Chills	5(1.4%)
Diarrhea, nausea	3(0.8%)
Disorder of smell and taste	2(0.5%)

Vaccine injection and viral pneumonia

3 doses of vaccine (n=181)	7(3.9%)
2 doses of vaccine (n=144)	6(4.2%)
1 dose of vaccine (n=9)	2(22.2%)
Unvaccinated (n=11)	2(18.2%)
Unknown (n=19)	1(5.3%)
Total (n=364)	18(4.9%)

Note: Data are numbers of patients, with percentages in parentheses.

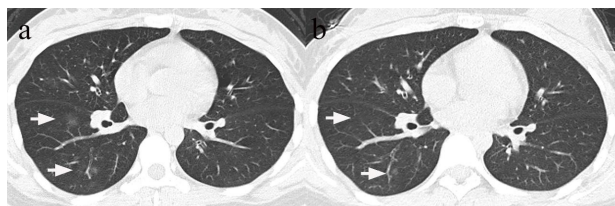


Fig. 2 Female, 21 years old. CT changes in a patient with coronavirus pneumonia. Lung lesions were rapidly absorbed. a. Multiple GGO in the right lung lobes on day 1; b. GGO lesions were significantly absorbed on day 9. GGO: ground glass opacity.

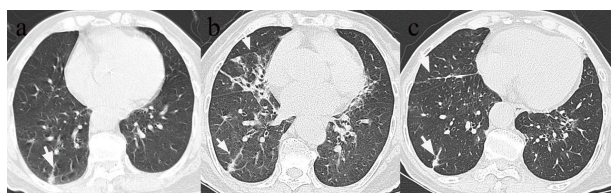


Fig. 3 Female, 74 years old. Dynamic changes in lung abnormality on CT images during the disease course. The lesions increased initially and then were absorbed thereafter. However, residual stripes were observed. a. Consolidation in the lower lobe of the right lung on day 1; b. Consolidation in one lobe progressed to GGO+consolidation+stripes in multi-lobes on day 8; c. Consolidation and GGO were absorbed on day 18, and fibrous stripes remained. GGO: ground glass opacity.

11 patients received three or more CT scans. On the first CT, GGO was identified as the most common pulmonary lesion, and seven patients showed GGO (7/11). Compared to the first CT, the second CT showed a reduction of GGO from seven to six, while mixed lesions (consolidation mixed GGO and stripe) appeared in two patients. In the third CT examination, the pulmonary lesions of five patients were completely absorbed (5/11), and the remainder were pure GGO (2/11) or mixed lesions mainly composed of GGO (4/11). The specific changes are shown in **Figure 4**.

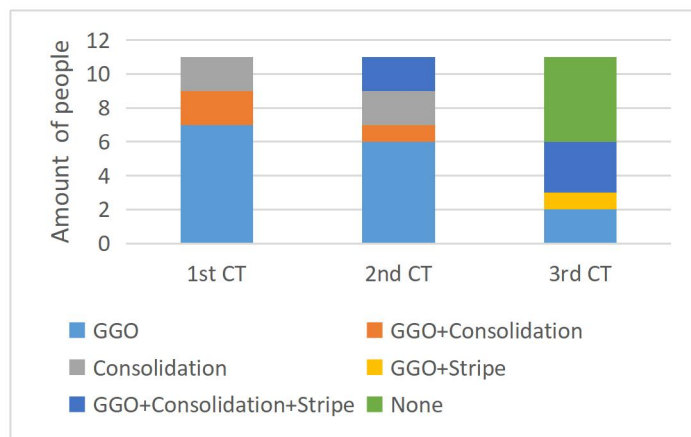


Fig. 4 Temporal change of chest CT in patients who have undergone three or more CT examinations

4. DISCUSSION

A systematically described longitudinal changes in CT examination in patients with Omicron infection were presented in this study. In patients with Omicron, the incidence of pulmonary infection was relatively low. The positivity rate of CT scans was 4.9% (18/364), which was significantly lower than that of the first wave of the pandemic (86.2%, 840/975), as previously reported [11]. This can explain the low rate of intensive care unit admissions associated with Omicron infection, while the potential effect elicited by vaccines cannot be excluded. Non-vaccinated patients had an increased risk of pulmonary infection compared with vaccinated patients

(4.5% vs. 18.2%), highlighting vaccination's effectiveness.

The number of lung segments involved in the patients with Omicron was less than that of previous variant strains, and most of them reached the peak on admission, and then decreased rapidly. It was significantly different from the previous strains which peaked after 6-11 days and maintained a high level for a longer period [12]. Based on imaging findings, this confirmed the low severity of pulmonary inflammation in Omicron patients. As well, the protective effect of the vaccine on patients should be considered. Additionally, these patients with Omicron infection received effective treatment at the early stage of the disease because of active therapeutic strategies. When large-scale infection occurred and medical resources were insufficient, it was worth considering whether the severity of pulmonary inflammation and even the mortality rate of the patients infected with Omicron could maintain such a low level. For example, at the beginning of the epidemic of COVID-19, the mortality rate in Wuhan was significantly higher than that in other regions [13].

GGO was the most common radiological manifestation on CT scans, which was consistent with other variant strains [14-17]. With the progress of the disease, pulmonary abnormalities were mixed lesions, and then partially absorbed. The residual lesions were pure GGO or mixed lesions mainly composed of GGO. Compared with the past, there were fewer residual lesions. Combined with the study of Yoon SH [8], the previous virus strains mainly involved the interstitium of the lung including the pulmonary vessels, while Omicron mainly involved the bronchovascular bundle and the surrounding, so the residual lesions were less.

The current study has the following limitations: 1) the participants included were mainly from Guangdong province or Hong Kong, which indicated a single source; 2) the sample size was small, in addition, no severe patients were included in the study, further confirmation with a larger sample size is required; 3) follow-up CT was not scheduled at fixed intervals; 4) the associations of CT manifestations with other clinicopathological data were not examined.

In conclusion, the Omicron variant has significantly lower pulmonary infection rates and fewer lung segments involved than the previous variant strains, lesions absorb more quickly and there are fewer residual lesions. However, the duration of pneumonia is longer in patients with underlying illnesses or those who are older.

CONFLICT OF INTEREST

There is no conflict of interest.

FUNDING

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