

# Comparison of Clinical, Laboratory and Radiological Characteristics Between COVID-19 and Adenovirus Pneumonia: A Retrospective Study

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**Background:** The pandemic of coronavirus disease 2019 (COVID-19) has become a global public health problem. It is important for clinical physicians to differentiate COVID-19 from other respiratory infectious diseases caused by viruses, such as human adenovirus.

**Subjects and Methods:** This was a retrospective observational study. We analyzed and compared the clinical manifestations, laboratory findings and radiological features of two independent cohorts of patients diagnosed with either COVID-19 (n=36) or adenovirus pneumonia (n=18).

**Results:** COVID-19 did not show a preference in males or females, whereas 94.4% of patients with adenovirus pneumonia were males. Fever and cough were common in both COVID-19 and adenovirus pneumonia. But the median maximal body temperature of the adenovirus pneumonia cohort was significantly higher than in COVID-19 ( $P<0.001$ ). Furthermore, 77.8% of patients with adenovirus pneumonia had a productive cough versus only 13.9% of COVID-19 patients ( $P<0.001$ ). Compared with adenovirus pneumonia, constitutional symptoms were less common in COVID-19, including headache (16.7% vs 38.9%,  $P=0.072$ ), sore throat (8.3% vs 27.8%,  $P=0.058$ ), myalgia (8.3% vs 61.1%,  $P<0.001$ ) and diarrhea (8.3% vs 44.4%,  $P=0.002$ ). Furthermore, patients with COVID-19 were less likely to develop respiratory failure (8.3% vs 83.3%,  $P<0.001$ ) and showed less prominent laboratory abnormalities, including lymphocytopenia (61.1% vs 88.9%,  $P=0.035$ ), thrombocytopenia (2.8% vs 61.1%,  $P<0.001$ ), elevated procalcitonin (2.8% vs 77.8%,  $P<0.001$ ) and elevated C-reactive protein (36.1% vs 100%,  $P<0.001$ ). Besides, a higher percentage of patients with adenovirus pneumonia showed elevated transaminase, myocardial enzymes, creatinine and D-dimer compared with COVID-19 patients. On chest CT, the COVID-19 cohort was characterized by peripherally distributed ground-glass opacity and patchy shadowing, while the adenovirus pneumonia cohort frequently presented with consolidation and pleural effusion.

**Conclusion:** There were many differences between patients diagnosed with COVID-19 and those with adenovirus pneumonia in their clinical, laboratory and radiological characteristics. Compared with adenovirus pneumonia, COVID-19 patients tended to show a lower severity of illness.

**Keywords:** coronavirus disease 2019, severe acute respiratory syndrome coronavirus 2, human adenovirus, adenovirus pneumonia, differential diagnosis

## Introduction

Since early December 2019, a newly emerged coronavirus, which was officially named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has been spreading worldwide.<sup>1</sup> Caused by SARS-CoV-2 infection and first identified in Wuhan, China,

coronavirus disease 2019 (COVID-19) has become a serious global public health problem. So far, confirmed cases of COVID-19 have been increasing rapidly, to over 34 million in 213 countries and areas, and have caused more than 230,000 confirmed deaths.<sup>2</sup>

Clinical manifestations of COVID-19 patients are quite non-specific, such as fever, dry cough and fatigue.<sup>3</sup> While peripherally distributed ground-glass opacity (GGO) in the lungs has been considered as the most important radiological feature of COVID-19, it is also frequently seen in other pulmonary viral infections.<sup>4</sup> This non-specificity makes it difficult to distinguish COVID-19 from other respiratory tract infections at first sight, especially from viral infections, such as human adenovirus. Human adenovirus is a group of double-stranded non-enveloped DNA viruses. Based on previous studies, it is responsible for at least 5–10% of pediatric and 1–7% of adult respiratory tract infections.<sup>5</sup> In recent years, several outbreaks of adenovirus pneumonia have been reported in different countries, which have caused high respiratory mortality.<sup>6–8</sup> Similarly to COVID-19, adenovirus pneumonia outbreaks usually occur in the winter or early spring. Both SARS-CoV-2 and human adenovirus can be transmitted through respiratory droplets and direct contact, cause severe respiratory tract infections and rapidly progress to respiratory failure. Radiological features of adenovirus pneumonia also partially overlap those of COVID-19. Thus, in the latest official clinical guideline released by the National Health Commission of China,<sup>9</sup> differential diagnosis between COVID-19 and adenovirus pneumonia was deemed necessary for suspected COVID-19 cases on admission.

Therefore, in the present study, we retrospectively analyzed and compared the clinical, laboratory and radiological features of COVID-19 and adenovirus pneumonia. It is hoped that our findings will help more clinical physicians to characterize these two diseases in the early stage of the clinical course.

## Subjects and Methods

### Study Design and Participants

This was a retrospective study among patients diagnosed with COVID-19 or adenovirus pneumonia. A total of 36 consecutive patients with laboratory-confirmed SARS-CoV-2 infection who were admitted to the Department of Respiratory Medicine of Central South University Xiangya Hospital and the Second People's Hospital of Chenzhou

from January 15 to March 20, 2020 were enrolled in this study. COVID-19 was diagnosed according to the WHO interim guidance.<sup>10</sup> Diagnosis of COVID-19 in patients included in this study was made strictly based on the positive detection of virus nucleic acids, by either reverse-transcriptase polymerase chain reaction (PCR) or next-generation sequencing. Meanwhile, the medical records were reviewed of 18 consecutive patients with adenovirus pneumonia, which was diagnosed based on the positive detection of virus nucleic acids in bronchoalveolar lavage fluid or blood samples by next-generation sequencing, at the Department of Respiratory Medicine of these two hospitals from November 1, 2018 to March 20, 2020. Routine microbiological detection tests were performed in all patients on admission, including culture of bacteria and fungi, serological tests (specific to human adenovirus, respiratory syncytial virus, influenza B virus, influenza A virus, human parainfluenza viruses, *Mycoplasma pneumoniae*, *Chlamydia pneumoniae*, *Legionella pneumophila* and *Coxiella burnetii*) and PCR of influenza viruses. Patients who met any of the following criteria were excluded: 1) patients younger than 14 years old; 2) patients with confirmed co-infection with other pathogens by routine microbiological detection on admission, including culture of bacteria and fungi, serological tests and PCR of influenza viruses; 3) patients with confirmed or suspected active tuberculosis; 4) pregnant or breast-feeding women; and 5) patients whose medical records were incomplete.

### Data Collection

Baseline clinical characteristics, and laboratory and radiological findings of each patient on hospital admission were obtained from electronic medical records. Clinical characteristics included the age, gender, smoking history, symptoms and underlying diseases of patients. Laboratory indicators included blood cell count, blood chemical analysis, coagulation testing, liver and renal function, procalcitonin (PCT), C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), lactate dehydrogenase (LDH) and creatine kinase (CK). Radiological assessments were made based on chest computed tomography (CT). The presence of a radiological abnormality was determined according to the documentation or description in the medical records, which was double-checked by two senior radiologists.

## Statistical Analysis

Statistical analysis was performed using SPSS 25.0 software (IBM Corp., Armonk, NY, USA). Continuous variables are presented as medians and interquartile ranges, and categorical variables as counts and percentages. The Mann–Whitney *U*-test was used to compare continuous variables between COVID-19 and adenovirus pneumonia groups. For categorical variables, differences between these two groups were assessed with the chi-squared test or Fisher's exact test. Significance was fixed at  $P<0.05$ .

## Ethics Statement

This study was approved by the Institutional Review Board and Ethics Committee of Central South University. The ethics committee approved the waiver of informed consent owing to the retrospective nature of the review. All research data accessed were de-identified and anonymously analyzed. The study was conducted according to the Declaration of Helsinki.

## Results

### Clinical Characteristics of Patients with COVID-19 or Adenovirus Pneumonia

Clinical characteristics of patients with COVID-19 or adenovirus pneumonia are summarized in Table 1. In total, there were 36 patients with COVID-19 and 18 patients with adenovirus pneumonia enrolled in the present study. The median ages of these two groups were similar (41 vs 34 years old,  $P=0.135$ ). COVID-19 did not show a preference in male or female populations, whereas patients with adenovirus pneumonia were almost exclusively male (17/18). Fever, cough and fatigue were the most common symptoms in COVID-19 patients, and were observed in 77.8%, 69.4% and 44.4% of cases, respectively. Fever was observed in all patients with adenovirus pneumonia, and their median maximal body temperature was significantly higher than in COVID-19 patients (40.0 vs 38.0°C,  $P<0.001$ ). Furthermore, 94.4% of patients with adenovirus pneumonia had a cough, and 77.8% showed expectoration, instead of a dry cough as in COVID-19. Compared with COVID-19, hemoptysis (27.8% vs 0.0%,  $P=0.001$ ), dyspnea (50.0% vs 11.1%,  $P=0.002$ ), myalgia (61.1% vs 8.3%,  $P<0.001$ ) and diarrhea (44.4% vs 8.3%,  $P=0.002$ ) were significantly more common in adenovirus pneumonia. In terms of underlying diseases, there was no significant difference in the history of chronic obstructive pulmonary disease, diabetes, hypertension, coronary heart

disease, chronic liver disease or chronic renal disease between the COVID-19 and adenovirus pneumonia cohorts.

### Laboratory Findings of Patients with COVID-19 or Adenovirus Pneumonia

Table 2 presents the laboratory findings of patients with COVID-19 or adenovirus pneumonia. The median white blood cell counts were comparable in the two groups (4.5 vs  $4.6\times 10^9$  cells/L,  $P=0.707$ ). Leukocytopenia (defined as white blood cell count  $<4\times 10^9$  cells/L) was seen in the same percentage (38.9%) of COVID-19 patients and adenovirus pneumonia patients. Median neutrophil counts of COVID-19 and adenovirus pneumonia cohorts were not statistically different ( $4.1$  vs  $2.8\times 10^9$  cells/L,  $P=0.137$ ). However, compared with COVID-19, patients with adenovirus pneumonia had a significantly lower median lymphocyte count ( $0.50$  vs  $0.98\times 10^9$  cells/L,  $P<0.001$ ) and median platelet count ( $88$  vs  $169\times 10^9$  cells/L,  $P=0.002$ ). Lymphocytopenia, which was defined as a lymphocyte count of less than  $1.1\times 10^9$  cells/L, occurred in 61.1% of COVID-19 and 88.9% of adenovirus pneumonia patients ( $P=0.035$ ). An elevated level of PCT was present in 2.8% of COVID-19 patients, CRP in 36.1% and ESR in 41.7%. In comparison, 77.8% of patients with adenovirus pneumonia showed elevated PCT ( $P<0.001$ ), 100% showed elevated CRP ( $P<0.001$ ) and 44.4% showed elevated ESR ( $P=0.846$ ). Elevated levels of aspartate aminotransferase (11.1% vs 94.4%), alanine aminotransferase (13.9% vs 72.2%), lactic dehydrogenase (50.0% vs 100%), creatine kinase (8.3% vs 100%) and D-dimer (13.9% vs 83.3%) were significantly less common in COVID-19 patients ( $P<0.001$ ). In addition, patients with adenovirus pneumonia showed a significantly higher median creatinine level than COVID-19 patients (90.1 vs 63.0  $\mu\text{mol/L}$ ,  $P<0.001$ ).

### Radiological Features of Patients with COVID-19 or Adenovirus Pneumonia

As shown in Table 3, both the COVID-19 and adenovirus pneumonia cohorts mainly presented with bilateral (72.2% vs 88.9%,  $P=0.165$ ) and multifocal (91.7% vs 100%,  $P=0.208$ ) pulmonary lesions on chest CT. However, 91.7% of patients with COVID-19 presented with a peripheral distribution of pulmonary lesions, while patients with adenovirus pneumonia did not show this radiological pattern ( $P<0.001$ ). Patchy shadowing was common in both

**Table I** Clinical Characteristics of Patients with COVID-19 or Adenovirus Pneumonia

Characteristics	COVID-19	AdP	P value
	(n=36)	(n=18)	
Age (years), median (IQR)	41 (30–55)	34 (25–48)	0.135
Gender, n (%)			
Male	18 (50.0)	17 (94.4)	0.001
Female	18 (50.0)	1 (5.6)	
Smoking history, n (%)			
Current smoker	8 (22.2)	12 (66.7)	0.006
Former smoker	1 (2.8)	0 (0.0)	
Non-smoker	27 (75.0)	6 (33.3)	
Clinical symptoms, n (%)			
Fever	28 (77.8)	18 (100)	0.03
$T_{max}$ (°C)	38.0 (37.5–38.5)	40.0 (39.5–40.1)	<0.001
Chills	3 (8.3)	6 (33.3)	0.02
Cough	25 (69.4)	17 (94.4)	0.037
Expectoration	5 (13.9)	14 (77.8)	<0.001
Hemoptysis	0 (0.0)	5 (27.8)	0.001
Fatigue	16 (44.4)	6 (33.3)	0.433
Chest pain	1 (2.8)	3 (16.7)	0.066
Dyspnea	4 (11.1)	9 (50.0)	0.002
Nasal congestion	2 (5.6)	1 (5.6)	0.946
Rhinorrhea	2 (5.6)	1 (5.6)	0.946
Headache	6 (16.7)	7 (38.9)	0.072
Sore throat	3 (8.3)	5 (27.8)	0.058
Myalgia	3 (8.3)	11 (61.1)	<0.001
Conjunctival congestion	2 (5.6)	0 (0.0)	0.308
Nausea or vomiting	4 (11.1)	4 (22.2)	0.279
Diarrhea	3 (8.3)	8 (44.4)	0.002
Underlying disease, n (%)			
COPD	2 (5.6)	0 (0.0)	0.308
Diabetes	1 (2.8)	0 (0.0)	0.475
Hypertension	3 (8.3)	0 (0.0)	0.208
Coronary heart disease	4 (11.1)	0 (0.0)	0.142
Chronic liver disease	4 (11.1)	2 (11.1)	1
Chronic renal disease	0 (0.0)	1 (5.6)	0.153

**Abbreviations:** COVID-19, coronavirus disease 2019; AdP, adenovirus pneumonia;  $T_{max}$ , maximal body temperature; COPD, chronic obstructive pulmonary disease.

COVID-19 and adenovirus pneumonia (77.8% vs 100%,  $P=0.030$ ). GGO (88.9% vs 22.2%,  $P<0.001$ ) and interstitial abnormalities (36.1% vs 5.6%,  $P=0.016$ ) were much more frequent in COVID-19 compared with adenovirus pneumonia. Only 2.8% of patients with COVID-19 showed consolidation or pleural effusion. In comparison, 77.8% of patients with adenovirus pneumonia showed consolidation and 72.2% showed pleural effusion. Pericardial effusion and lymphadenopathy were rarely seen in COVID-19, while in the adenovirus pneumonia cohort, pericardial effusion was observed in 16.7% and

lymphadenopathy in 33.3% of patients. [Figure 1](#) shows representative chest CT images of patients with COVID-19 and adenovirus pneumonia. COVID-19 was characterized by multiple GGO distributed in the peripheral zone of multiple lobes. However, the most typical abnormalities of adenovirus pneumonia on chest CT were bilateral consolidation, patchy shadowing and pleural effusion.

## Discussion

In this study, we compared the clinical, laboratory and radiological features of patients with COVID-19 and adenovirus

**Table 2** Laboratory Findings of Patients with COVID-19 or Adenovirus Pneumonia on Admission

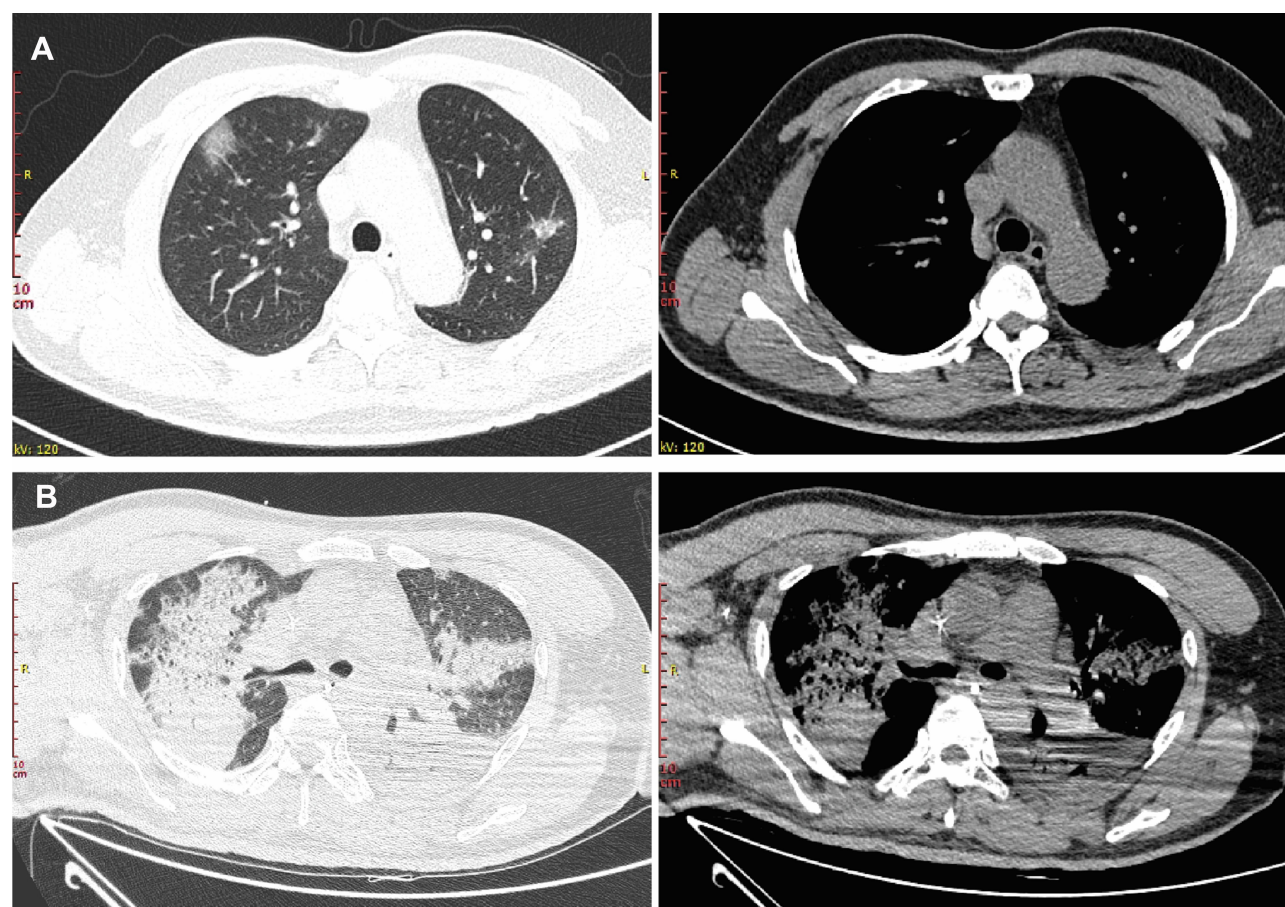
Variables	COVID-19	AdP	P value
	(n=36)	(n=18)	
PaO <sub>2</sub> /FiO <sub>2</sub> <300 mmHg, n (%)	3 (8.3)	15 (83.3)	<0.001
WBC (×10 <sup>9</sup> /L), median (IQR)	4.5 (3.6–5.8)	4.6 (3.4–7.5)	0.707
<4×10 <sup>9</sup> /L, n (%)	14 (38.9)	7 (38.9)	1
>10×10 <sup>9</sup> /L, n (%)	0 (0.0)	1 (5.6)	0.316
Neutrophils (×10 <sup>9</sup> /L), median (IQR)	2.8 (2.4–4.4)	4.1 (2.5–6.4)	0.137
Lymphocytes (×10 <sup>9</sup> /L), median (IQR)	0.98 (0.75–1.44)	0.50 (0.30–0.93)	<0.001
<1.1×10 <sup>9</sup> /L, n (%)	22 (61.1)	16 (88.9)	0.035
Hemoglobin (g/L), median (IQR)	133.5 (128.3–146.0)	136.5 (126.5–148.3)	0.941
Platelets (×10 <sup>9</sup> /L), median (IQR)	169 (137–229)	88 (75–195)	0.002
<100×10 <sup>9</sup> /L, n (%)	1 (2.8)	11 (61.1)	<0.001
PCT >0.5 ng/mL, n (%)	1 (2.8)	14 (77.8)	<0.001
CRP >10 mg/L, n (%)	13 (36.1)	18 (100)	<0.001
ESR >40 mm/h, n (%)	15 (41.7)	8 (44.4)	0.846
AST >40 U/L, n (%)	4 (11.1)	17 (94.4)	<0.001
ALT >40 U/L, n (%)	5 (13.9)	13 (72.2)	<0.001
Tbil >17.1 μmol/L, n (%)	11 (30.1)	6 (33.3)	0.836
LDH >250 U/L, n (%)	18 (50.0)	18 (100)	<0.001
CK ≥200 U/L, n (%)	3 (8.3)	18 (100)	<0.001
Creatinine (μmol/L), median (IQR)	63.0 (52.0–79.5)	90.1 (77.5–128.8)	<0.001
D-dimer >0.5 mg/L, n (%)	5 (13.9)	15 (83.3)	<0.001

**Abbreviations:** COVID-19, coronavirus disease 2019; AdP, adenovirus pneumonia; PaO<sub>2</sub>/FiO<sub>2</sub>, ratio of the partial pressure of arterial oxygen to the fraction of inspired oxygen; WBC, white blood cell; PCT, procalcitonin; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; AST, aspartate transaminase; ALT, alanine aminotransferase; Tbil, total bilirubin; LDH, lactate dehydrogenase; CK, creatine kinase.

**Table 3** Radiological Features of Patients with COVID-19 or Adenovirus Pneumonia on Chest CT

Radiological Abnormalities	COVID-19	AdP	P value
	(n=36)	(n=18)	
Unilateral involvement	10 (27.8)	2 (11.1)	0.165
Bilateral involvement	26 (72.2)	16 (88.9)	
Unifocal involvement	3 (8.3)	0 (0.0)	
Multifocal involvement	33 (91.7)	18 (100)	0.208
Peripheral distribution	33 (91.7)	0 (0.0)	<0.001
Ground-glass opacity	32 (88.9)	4 (22.2)	<0.001
Patchy shadowing	28 (77.8)	18 (100)	0.03
Interstitial abnormalities	13 (36.1)	1 (5.6)	0.016
Consolidation	1 (2.8)	14 (77.8)	<0.001
Pleural effusion	1 (2.8)	13 (72.2)	<0.001
Pericardial effusion	0 (0.0)	3 (16.7)	0.012
Lymphadenopathy	1 (2.8)	6 (33.3)	0.002

**Abbreviations:** COVID-19, coronavirus disease 2019; AdP, adenovirus pneumonia.



**Figure 1** Representative chest CT images of patients with COVID-19 or adenoviral pneumonia. **(A)** Chest CT of COVID-19 showing multiple peripherally distributed ground-glass opacities in bilateral lung. **(B)** Chest CT of adenovirus pneumonia showing bilateral consolidation and left-sided pleural effusion.

pneumonia. To the best of our knowledge, this is the first study focusing on the differential diagnosis between COVID-19 and adenovirus pneumonia. Our data showed that COVID-19 patients were more likely to exhibit mild-to-moderate fever and dry cough, while patients with adenovirus pneumonia usually had high fever and productive cough with more common constitutional symptoms. In addition, patients with adenovirus pneumonia were more likely to develop severely or critically ill subtypes and present more laboratory abnormalities, including lymphocytopenia, thrombocytopenia, and elevated serum levels of PCT, CRP, transaminase, myocardial enzymes, creatinine and D-dimer. On chest CT, COVID-19 was characterized by peripherally distributed GGO and patchy shadowing, while adenovirus pneumonia mainly presented as patchy shadowing, consolidation and pleural effusion.

SARS-CoV-2 is a highly infectious single-stranded enveloped RNA virus, and COVID-19 constitutes a threat to global public health. Early identification and diagnosis are crucial for interrupting the transmission of COVID-19. Because of the

non-specific clinical symptoms and radiological changes, confirmed diagnosis of COVID-19 relies on the detection of SARS-CoV-2 nucleic acid.<sup>11</sup> However, the problem is that false-negative results are frequently seen in COVID-19. A retrospective study including 1014 cases suspected of having COVID-19 revealed that only 59% of them had positive RT-PCR results. Among 413 patients with negative RT-PCR results, 36% had typical chest CT findings of COVID-19 and were considered as highly likely cases.<sup>12</sup> Fang et al<sup>13</sup> found that, in a cohort of 51 COVID-19 patients who had throat swabs (45 patients) or sputum samples (six patients) taken, followed by one or more RT-PCR assays, the sensitivity of RT-PCR of the throat swab or sputum sample was only 71%. Xiao et al<sup>14</sup> reported that 21.6% of patients with COVID-19 received false-negative results in the first and second consecutive tests for SARS-CoV-2 nucleic acid with nasopharyngeal or oropharyngeal swabs. Therefore, analysis of the similarities and differences in clinical, laboratory and radiological characteristics between COVID-19 and other viral pneumonias,

including adenovirus pneumonia, is of significance in clinical practice.

Our data showed that there were similarities and differences between COVID-19 and adenovirus pneumonia. Consistent with previous studies, both COVID-19 and adenovirus pneumonia were characterized by fever and cough.<sup>15</sup> However, patients with COVID-19 mainly had mild-to-moderate fever and dry cough, while patients with adenovirus pneumonia exclusively had high fever ( $T_{\max} > 39^{\circ}\text{C}$ ) and productive cough. Besides, constitutional symptoms such as headache, sore throat, myalgia and gastrointestinal symptoms (including nausea, vomiting and diarrhea) were more common in the adenovirus pneumonia cohort than in COVID-19. In terms of laboratory findings, we found that, compared with COVID-19, adenovirus pneumonia had more prominent laboratory abnormalities, including lymphocytopenia, thrombocytopenia, and elevated levels of inflammatory markers such as PCT and CRP. Target organ injuries were also more common in adenovirus pneumonia, including liver, heart and kidney, which were indicated by the higher percentage of patients revealing elevated levels of transaminases, muscle enzymes and creatinine. These differences in clinical features and laboratory findings could provide valuable clues for clinical physicians to differentiate COVID-19 from adenovirus pneumonia.

According to the latest official guidance issued by the Health Commission of China, chest CT scan, which shows a higher sensitivity (86–98%) and improved false-negative rates compared to RT-PCR,<sup>16</sup> is considered the main diagnostic basis of COVID-19 when SARS-CoV-2 nucleic acid testing is negative. In our study, both COVID-19 and adenovirus pneumonia were characterized by bilateral multifocal pulmonary lesions. Specifically, GGO and interstitial abnormalities were much more frequent in COVID-19, whereas consolidation and pleural effusion were more common in adenovirus pneumonia, which is consistent with previous studies.<sup>4,17</sup> The peripheral distribution of pulmonary lesions was unique in COVID-19. Therefore, this radiological feature strongly suggests the diagnosis of COVID-19, instead of adenovirus pneumonia.

It is worth noting that, overall, patients with adenovirus pneumonia had more critical conditions than those with COVID-19 in our study. The incidence rate of respiratory failure, which was defined as  $\text{PaO}_2/\text{FiO}_2 \leq 300 \text{ mmHg}$ , was markedly lower in COVID-19 compared to adenovirus pneumonia. Laboratory abnormalities indicating target organ injuries, such as heart, liver and kidney, were also less common in COVID-19. The high virulence of human adenovirus could be

one reason for this. Adenovirus pneumonia requiring hospitalization is uncommon in adults, and current knowledge is mainly derived from small case series. Even though the pathogenic mechanism of human adenovirus remains unclear, it has been reported to be an important viral cause of acute respiratory distress syndrome (ARDS) and respiratory mortality.<sup>18</sup> Adenovirus genotypes 7 and 55 can infect both immunocompetent and immunocompromised individuals, and have been implicated in outbreaks of severe pneumonia and ARDS, even in immunocompetent young men.<sup>19–23</sup> In the present study, all patients with adenovirus pneumonia were young or middle-aged immunocompetent individuals, which also supported the high virulence of human adenovirus. Among patients with adenovirus-associated ARDS, the mortality could be as high as 80%.<sup>23</sup> La Rosa et al<sup>24</sup> reported that human adenovirus had a mortality rate of 26% in 76 adult recipients of hematopoietic stem cell transplantation. Furthermore, the national health policy also increased the percentage of hospitalized patients with mild-to-moderate COVID-19. Since the outbreak of COVID-19, the Chinese government has been making every effort to control the sources of infection and cut the chain of transmission. SARS-CoV-2 testing kits and medical care services are freely provided to all confirmed COVID-19 cases, so that many patients with mild-to-moderate COVID-19 are admitted to hospital for isolation and treatment. However, patients with mild adenovirus pneumonia only present non-specific and self-limiting respiratory symptoms. Thus, most of these patients may not be admitted to hospitals.

There are several limitations to the present study. First of all, this was a retrospective study that included data from two centers, which may have caused unavoidable selection bias. Second, the total patient number was small; in particular, there were only 18 patients with adenovirus pneumonia enrolled in this study owing to its low incidence. The small sample size could have reduced the representativeness of these patients. Finally, the data for the adenovirus pneumonia cohort originated from a 2-year span, while the data for the COVID-19 cohort originated from a 2-month span, which may also affect the present results.

## Conclusion

There were many differences between COVID-19 and adenovirus pneumonia in their clinical, laboratory and radiological characteristics. Compared with adenovirus pneumonia, COVID-19 patients tended to show a lower severity of illness. Large-scale studies are needed in the future to provide more experience in differentiating COVID-19 from not only

adenovirus pneumonia but also other viral infections in the respiratory tract.

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## Disclosure

The authors report no conflicts of interest in this work.

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